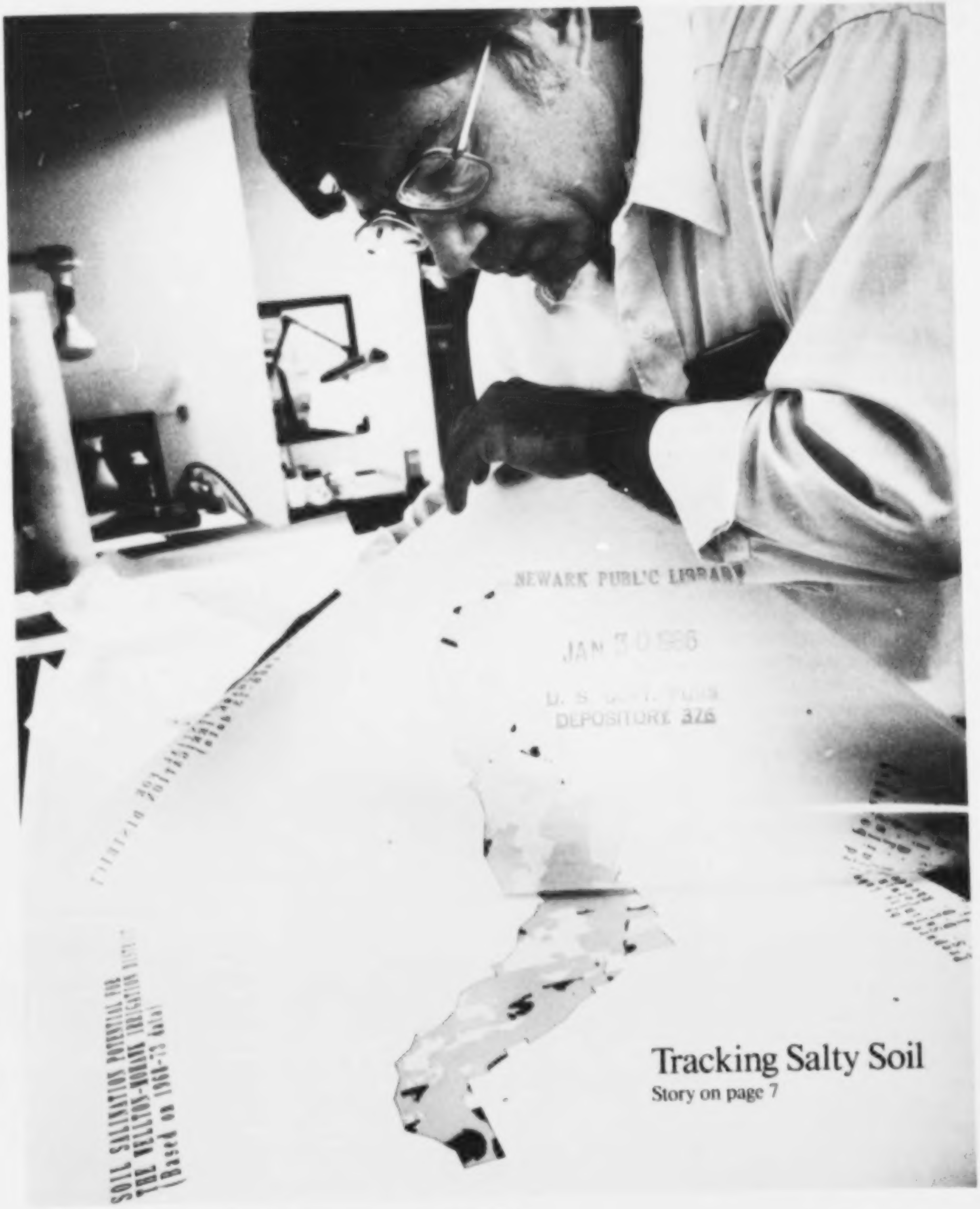
34/1

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 1, January 1986

Agricultural Research


SOIL SALINATION POTENTIAL FOR
THE WELLTON-MOHAWK IRRIGATION DISTRICT
(Based on 1968-73 data)

NEWARK PUBLIC LIBRARY
JAN 30 1986
U. S. GOVT. PUBS
DEPOSITORY 376

Tracking Salty Soil

Story on page 7

READEX FICHE best copy available

A 77.12:

Scientist Thwarts Yield-Robbing Fungi

The Agricultural Research Service has named plant pathologist R. James Cook the 1985 Distinguished Scientist of the Year for protecting the world's leading food grain from root diseases. The award is the highest given by the Agency for scientific achievement and leadership among its employees.

This year's recipient is a scientist who believes that modern wheat still falls short of its true potential yield. His research, spanning 20 years at the Agricultural Research Service's Root Disease and Biological Control Unit in cooperation with Washington State University at Pullman, WA, bears out this conclusion.

As one of the world's leading authorities on fungal diseases of wheat, Cook has found ways to reduce the effects of three major root diseases attacking wheat in the principal wheat-growing areas of the Pacific Northwest.

In the critically eroding fields of eastern Washington and northern Idaho, conservation tillage's chances for adoption were boosted when Cook discovered that the fungus *Pythium* was limiting conservation tillage wheat yields to 60 to 75 percent of their potential.

Conservation tillage is a practice that reduces erosion by limiting the amount of soil disturbed by tillage and leaving as much of the previous crop's residue on the surface as is needed to protect the soil. Growers in the Palouse have been slow to accept conservation tillage because of lowered wheat yields.

Cook says the residue left on the field acts like a wet blanket, keeping soil cool and damp, which is very conducive to growth of *Pythium* and other soil fungi.

Once the real culprit was known, Cook's research team went on to isolate an antibiotic-producing bacterium that can colonize wheat roots and protect them from *Pythium*. Cook is also testing seeds coated with a chemical control for the disease.

In drier production areas of the Pacific Northwest, Cook and his colleagues found that the key to controlling another disease, *Fusarium* foot rot, was to keep wheat plants from becoming stressed for water. They recommended reducing the amount of nitrogen applied to reduce leaf size, planting late to keep plants smaller, and choosing varieties bred to withstand water stresses. In a 100,000-acre area afflicted by *Fusarium*, wheat farmers who followed these recommendations increased their yields by about 10 bushels per acre.

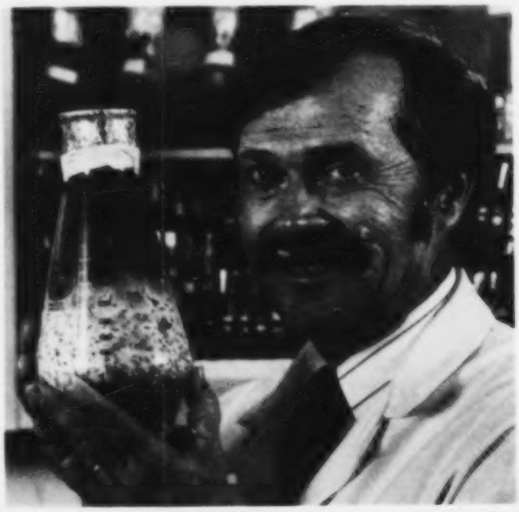
Another disease—aptly named "take-all" by Australian pioneers—is the world's most important wheat root disease. It is caused by the fungus *Ophiobolus graminis*. Cook began studying take-all in 1967 and as a result of research on the ecology and general biology of the soil fungus, found ways to control it by managing tillage, irrigation, fertilizers, and soil acidity.

Farmers raising wheat on the irrigated acres of the Columbia Basin of Washington and the Snake River Plain of southern Idaho do not find take-all as drastic as the name implies but still consider it a serious problem. Growers who packaged Cook's recommendations into a management program averaged 110 to 120 bushels per acre (in 1982), even in fields where wheat was planted for several years in a row.

A bacterium that suppresses take-all is in its fifth year of field-testing. To do this work, Cook and plant pathologist David M. Weller, have developed and patented a way to separate effective strains of bacteria from the many ineffective strains.

Possibly more important than a bacteriological approach to take-all control is discovery of a potential self-destruct mechanism in the fungus itself. The scientists know the mechanism is genetically controlled but need to examine it further as a possible biological control tool. Cook says Linda S. Thomashow, a molecular geneticist, joined him and Weller this year so the team could pursue this line of research.

The chance to work with Cook and his colleagues on wheat research has attracted visiting scientists and students from England, Australia, Brazil, Japan, Korea, the People's Republic of China, Thailand, France, and Germany, as well as from within this country. Many are now making significant scientific contributions in their own right.—**L.E.M.**


Cook with laboratory culture of root rot fungus. (1085X1040-4)

Agricultural Research

Cover: Agricultural Research Service soil scientist James Rhoades, Riverside, CA, looks at computer-made overlay maps showing areas of irrigated land with potential salt problems. Techniques developed by Rhoades and others should help predict salinity trouble spots throughout the world. Story begins on page 7. (1185X1215-26A)

p. 11

7 Tracking Salty Soil, Saving Fresh Water

Scientists offer solutions to problems that have plagued irrigated agriculture for thousands of years.

11 Rhizomania Threatens Sugarbeet Industry

Growers may not know thay have a problem until time to harvest.

12 Groundwater Movement Studied

Surface water and dissolved chemicals join the underground water supply much more rapidly than previously thought.

p. 12

DEPARTMENTS

4 Agnotes

Have You Had Your Chromium Today?
Antipollution Injection for Trees
In the Clover With Bigbee
Beyond the Root Zone
Stored Grain Spraying—Less Water?
New Weed Spreading in Upper Midwest
Computer Simulates Ideal Forage Use
Chronic Obesity May Lead to Mineral Deficiency

14 Technology

Temperature Integrator Reduces Spraying
Freeze-Dried Seeds Really Last
New Detector for Hidden Injuries in Fruit

16 Patents

Sure Way to Diagnose Livestock Disease
Curing Hides Faster
Better Zinc, Iron, and Chromium Supplements

p. 5

Vol. 34, No. 1
January 1986

Editor: Lloyd E. McLaughlin
Assistant Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

John R. Block, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Have You Had Your Chromium Today?

Probably not. A week-long test of the normal diets of 32 adults in the Washington, DC, area revealed that all consumed less than the recommended amount.

The National Academy of Sciences suggests a minimum of 50 micrograms of chromium a day as safe and adequate.

For the test at the Vitamin and Mineral Nutrition Laboratory in Beltsville, MD, 32 volunteers brought in duplicate amounts of everything they ate and drank. Then the food was analyzed for amounts of vitamins and minerals.

Another test at the Vitamin and Mineral lab showed those who exercise strenuously may need more chromium than others. The nine men studied lost twice as much chromium in their urine on days they ran 6 miles than on days they did not run.

Physical stress caused by severe injuries seems to have an effect similar to exercise. In cooperative studies at the University of Maryland's Neurotrauma Intensive Care Unit in Baltimore, seven severely injured patients lost abnormally high amounts of chromium in their urine. The rate of chromium loss decreased as the patients recuperated, according to chemist Marilyn M. Polansky.

Chemists Mary Howard (left) and Marilyn Polansky take a blood sample from chemist Richard Anderson. Anderson, a jogger, participated in a study of the effect of strenuous exercise on blood sugar and chromium levels. (0584W546-21)

Richard A. Anderson, also a chemist, says tests at the lab have revealed that chromium maintains blood-sugar levels and helps regulate fats and cholesterol, even increasing high-density lipoproteins (HDL), the "good" cholesterol.

Anderson says foods such as whole wheat breads, meat, mushrooms, and vegetables are good sources of chromium. A varied diet containing these foods can be expected to provide enough chromium to maintain good health.—**Vince Mazzola,** Beltsville, MD.

Richard A. Anderson and Marilyn M. Polansky are at the USDA-ARS Vitamin and Mineral Nutrition Laboratory, Room 224, Building 307, Beltsville, MD 20705. ■

Antipollution Injection for Trees

A chemical injected into shade trees can reduce leaf damage from ozone pollution by as much as 94 percent.

Ozone, a major air pollutant, damages crops and causes tree leaves to yellow, wither, and fall. It also reduces vigor and growth, leaving trees vulnerable to attack by insects and disease.

Bruce R. Roberts, a plant physiologist with the Agricultural Research Service in Delaware, OH, has found that ethylenediurea (EDU) protects tree leaves from ozone damage.

"How EDU protects plants from ozone is not well understood. But our test results indicate that when it is injected directly into the stem, it alters enzyme and membrane activity within the leaf cells where photosynthesis takes place," Roberts says.

Tree seedlings were treated with the chemical by two different methods a week before being fumigated with ozone. Leaves were checked for damage within 6 days after fumigation.

The seedlings were exposed to 0.30 and 0.95 parts per million of ozone, well above the range normally found in smog.

Roberts and coworkers at the Nursery Crops Research Laboratory found injecting EDU into a small cut in the stem was more efficient than drenching the soil around potted seedlings.

Injecting honeylocust, red maple, pin oak, and sweetgum seedlings gave better protection—up to 94 percent compared with a high of 48 percent for drenching—using only one-fiftieth as much EDU solution.

Roberts chose 2-year-old seedlings so they would fit in the fumigation chambers but says EDU injection should protect mature trees as well. "We feel that EDU is a relatively safe chemical for protecting leaves of most trees and shrubs from ozone damage," he says.—**Betty Solomon,** Peoria, IL.

Bruce R. Roberts is at the USDA-ARS Nursery Crops Research Laboratory, 359 Main Road, Delaware, OH 43015. ■

In the Clover With Bigbee

A new winter-hardy clover has been developed for the southern United States.

William E. Knight, an agronomist with the Agricultural Research Service in Mississippi, said that Bigbee is the only berseem clover that can survive across the South. Berseem clovers, also called Egyptian clovers, are extensively cultivated in the Nile Valley and to some extent in the southwestern United States and California. These clovers are generally more succulent than alfalfa and other clovers.

Knight says the clover he named Bigbee "has a level of cold tolerance comparable to arrowleaf and crimson clover." It "will benefit livestock producers because it has more fall and winter growth than any other winter annual legume, with the exception of one variety of crimson clover. Moreover, Bigbee produces forage longer than any other winter legume and will grow late into May and even early June."

Although Bigbee is susceptible to root diseases common to other legume species, Knight says that none of his experimental stands have been lost to these diseases since he began the tests in 1977. Another advantage of the new clover to livestock producers is that not a single case of bloat (an often fatal accumulation of gas in the digestive system of ruminants) has ever been reported in animals feeding on berseem.

Finally, Bigbee differs from other berseems in that it produces an abundance of hard seed suitable for reseeding stands.

Breeder seed of Bigbee is being produced by ARS. Foundation seed is produced by the Mississippi Agricultural and Forestry Experiment Station, which participated in the release.—**Bennett Carriere,** New Orleans, LA.

William E. Knight is in USDA-ARS Forage Research, P.O. Box 272, Mississippi State, MS 39762. ■

Beyond the Root Zone

Forecasting potential effects on groundwater from pesticides will be easier because of changes in a prediction model.

The Chemicals Runoff and Erosion from Agricultural Management Systems (CREAMS) mathematical model has been modified to estimate the movement of pesticides below the root zone of crops. Previously, CREAMS estimated only movement across the land surface.

Limited testing of GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), the new groundwater contamination part of CREAMS, gave relatively good results compared with observed data on sandy soils in the southeastern United States.

The next task will be to add the effects of nutrients, mainly nitrates, to the model.

The Agricultural Research Service and the USDA Soil Conservation Service are testing GLEAMS in central Wisconsin.

The model will be used in a groundwater research project, in cooperation with the U.S. Geological Survey, to simulate the movement of farm chemicals through root zones.

Walter G. Knisel, Jr., a hydrological engineer, and Ralph A. Leonard, soil scientist, are conducting this research at the USDA-ARS Southeast Watershed Research Laboratory, P.O. Box 946, Tifton, GA 31793. ■

Stored Grain Spraying—Less Water?

Using less water to apply BT, a bacteria-based insecticide, in stored grain has been found just as effective as using the rate printed on the package, says William H. McGaughey, an entomologist with the Agricultural Research Service in Manhattan, KS.

This should reduce the concern of grain producers about mold risks caused by too much water being applied to stored grain, he says.

The discovery came during tests of application methods and performance of insecticides made from the bacterium *Bacillus thuringiensis* (BT) on about 65 cooperating farms in Illinois, Iowa, Kansas, Nebraska, and Oklahoma.

Using two commercial formulas of the insecticide, in both dust and wettable formulations, researchers reduced infestations of the Indianmeal moth by 50 to 60 percent in stored wheat and by more than 80 percent in corn.

To determine the effectiveness of *Bacillus thuringiensis* (BT) applied to grain with various amounts of water, entomologist William McGaughey examines Indian meal moth pupae trapped in a spool of corrugated paper. The percentage of dead pupae reveals the insecticide's effectiveness. (0985X1056-29)

ARS scientists found the insecticide's effectiveness essentially the same whether applied in a dust formula or a wettable powder, whether added to the grain as it is augered into the bin or whether raked into the surface of filled bins.

However, scientists did find that using 4 gallons of water per 500 square feet to apply the wettable powder was just as effective as the labeled rate of 10 gallons per 500 square feet.

McGaughey warns that it's illegal for grain producers to use less than 10 gallons of water until BT manufacturers obtain the approval of the Environmental Protection Agency and the label has been changed.

In the 3-year tests, 142 bins of wheat and 43 bins of corn were treated with BT and insect levels were measured and compared with those in 158 untreated bins.—**Linda Cooke-Stinson,** Peoria, IL.

William H. McGaughey is in USDA-ARS Biological Research at the U.S. Grain Marketing Research Laboratory, 1515 College Avenue, Manhattan, KS 66502. ■

New Weed Spreading in Upper Midwest

An annual weed common to northern China is becoming more of a problem for Minnesotans each year.

In 1984, Robert N. Andersen, an agronomist, and colleagues at the University of Minnesota, St. Paul, found prickly smartweed in more than 40 fields in 6 southern Minnesota counties and 1 northern Iowa county.

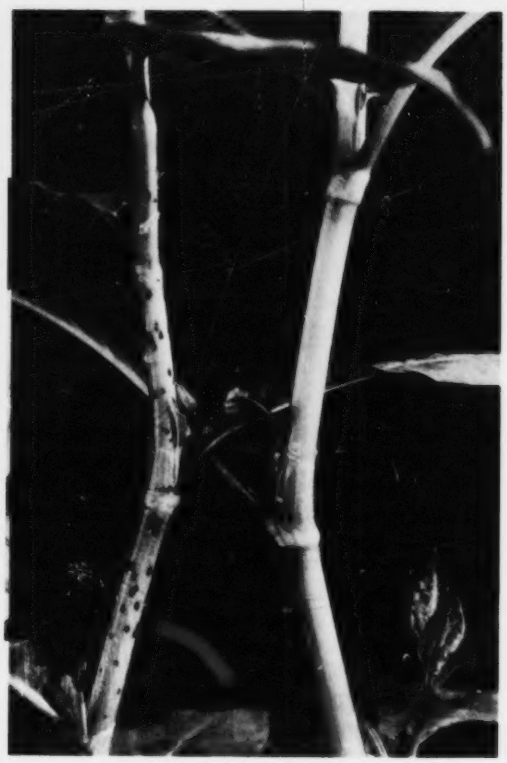
"Infestations ranged from only a few plants in a field to fields in which prickly smartweed was the dominant weed throughout the entire field," Andersen says. "The vigorous growth of the new weed in cropland suggests that it would be at least as competitive as the other annual smartweeds already well established in North America."

Prickly smartweed, identified as *Polygonum bungeanum* Turcz, is also found in Japan, Korea, Manchuria, and parts of the U.S.S.R. near Japan.

It differs from other common annual smartweeds found in the upper midwestern United States (ladysthumb, Pennsylvania smartweed, and pale smartweed) in that the plants of prickly smartweed develop tiny downward-pointing prickles and seeds that are almost round. Other smartweeds have no prickles, and the seeds are flat.

Prickly smartweed has not been reported previously as occurring in North America. "We have no idea how the weed came to this country," Andersen says. "It may have been introduced from Asia as long as 25 years ago."—**Betty Solomon,** Peoria, IL.

Robert N. Andersen is in USDA-ARS Plant Science Research at the University of Minnesota, Department of Agronomy and Plant Genetics, St. Paul, MN 55108. ■



Prickly smartweed (left) and Pennsylvania smartweed. (PN-7193)

Computer Simulates Ideal Forage Use

A computer model has been designed to help dairy farmers and researchers assess the impact of new methods for harvesting and storing forage under a wide range of management and climatic conditions.

Using local weather records dating back 26 years, C. Alan Rotz, Agricultural Research Service agricultural engineer, East Lansing, MI, used the model to find that in 9 years out of 10, harvesting alfalfa four times a year can be considered more profitable than cutting hay three times.

In developing the model, Rotz and graduate students at Michigan State University, East Lansing, integrated previous research results into submodels to predict the quantity and quality of alfalfa and corn produced under historical weather conditions. In a feeding submodel they allocated the highest quality feed to the high milk-producing cows. Other submodels dealt with harvest, storage, and handling of the forage.

In the overall model, predicted net dollar returns are compared for forage harvest and storage alternatives on dairy farms.—**Ben Hardin,** Peoria, IL.

C. Alan Rotz is assigned to the U.S. Dairy Forage Research Center, Madison, WI, and is in Room 207, Department of Agricultural Engineering, Michigan State University, East Lansing, MI 48824. ■

Chronic Obesity May Lead to Mineral Deficiency

Doctors have reported that some obese children and adolescents have low blood levels of iron and zinc. To study this phenomenon, scientists are turning to laboratory animals. In tests so far, obese rats do show significantly lower levels of zinc, iron, copper, and manganese in their tissues than their lean littermates.

Agricultural Research Service microbiologist Mark L. Failla is now studying the question of how chronic obesity alters tissue concentrations of these minerals and if marginal intake of minerals affects obese animals more severely than lean animals.

Mark L. Failla is at the USDA-ARS Beltsville Human Nutrition Research Center, Building 307, BARC-East, Beltsville, MD 20705. ■

Tracking Salty Soil, Saving Fresh Water

A pickup truck pulls off the highway and stops. A high school student gets out, removes a probe which is attached by wires to a backpack data recorder, swings the equipment over his back, and walks about 100 yards into an adjoining field. There he shoves the probe six inches into the soil and pushes a button to automatically record soil salinity and exact location in the field.

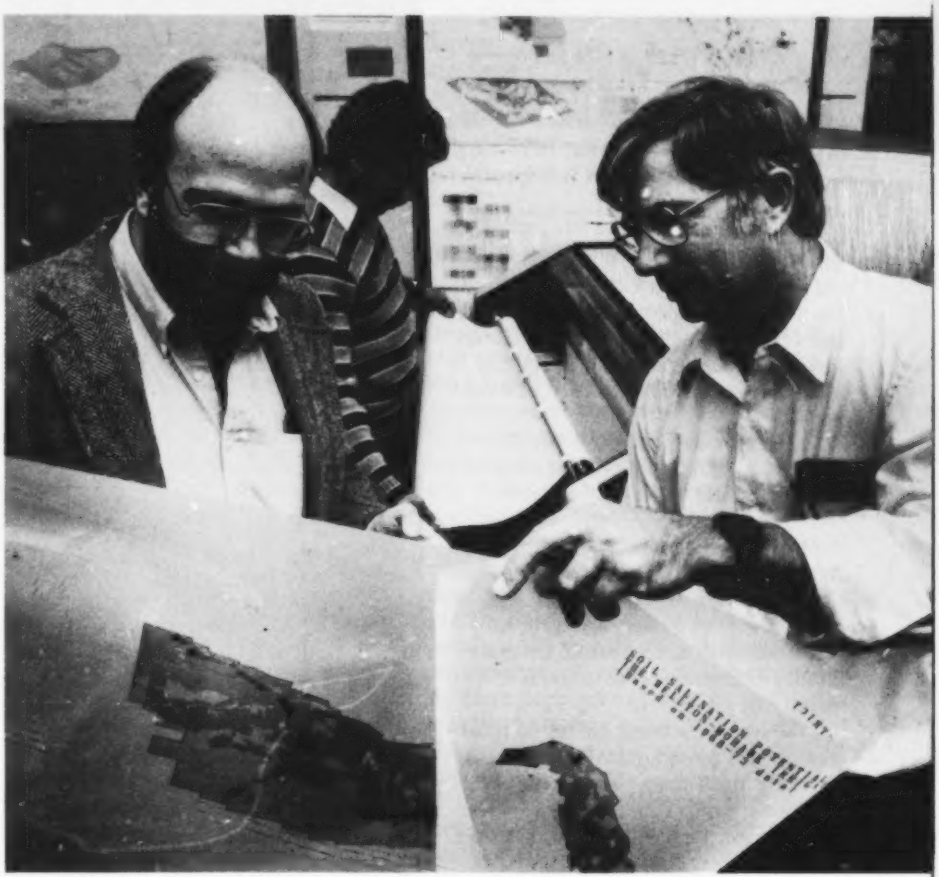
When several hundred such measurements have been recorded, the young employee returns to the local irrigation manager's office and electronically transmits the information into a computer. The computer, no larger than some home models, analyzes the information and prints a map that indicates areas where yield-reducing salts are accumulating in farmers' fields.

Agricultural Research Service scientists have developed the measuring probe, now commercially available, and the computer programs. They are now evaluating ways to make the large-scale collection of data economical, perhaps much like the technique portrayed above.

The USDA's Soil Conservation Service has contributed $100,000 this year to help make such soil salinity mapping possible.

Salinity, and the resulting decreased crop yields, has been a problem for irrigated agriculture for at least 4,000 years. Mesopotamia, an area between the Tigris and Euphrates Rivers in what is now Iraq, once flourished with agriculture and civilization. Salinity associated with irrigation slowly doomed the area—today a vast semidesert supporting only half the population it once did.

Salinity still plagues irrigated lands. Some of this country's most productive farmland is being lost to this natural phenomenon that has been accelerated by irrigation. California has 8.6 million acres of irrigated land and about half, 4.5 million acres, is affected to some degree by salinity. Similar problems are occurring throughout the western United States.


Cooperating University of California geographer Stephen McRae (left) discusses salinity maps with soil scientist James Rhoades. (1185X1214-7A)

Some estimates for foreign countries are particularly bleak. For example, one report estimates that 35 percent of India's irrigated land is seriously saline and that one-quarter to one-half of South America's irrigated acreage is adversely affected by salts.

"Estimates are educated guesses," says Jan van Schilfgaarde, former director of the U.S. Salinity Laboratory, Riverside, CA, "but until we develop ways to monitor the degree of increasing salinity, I won't argue with anyone who says we have a very serious problem both here and overseas."

"Long-term corrective action is needed to protect irrigated agriculture, but first we need to be able to detect the onset of problems and to predict where they will occur," says ARS soil scientist James D. Rhoades, Riverside.

Rhoades says salinity measuring is currently done in laboratories, and each sample can cost up to $25 with several dozen needed for each field. Such expense is prohibitive for mapping large areas.

"The sampling technique and maps we are developing will eliminate the major need for soil sampling and laboratory analysis. Cost figures haven't been calculated yet, but if we can get the system automated, it should cost a mere fraction compared with present techniques."

Maps that minimize the need for direct measurement use computer overlay techniques and can be

"I won't argue with anyone who says we have a very serious problem both here and overseas."
– Jan van Schilfgaarde.

likened to maps in some geography text books. Geographic features are printed on one page and additional information, such as how boundaries have changed over time, is printed on individual overlays made of clear plastic.

In this case, each overlay contains information on one factor that can contribute to salinity in soil.

These factors include water table depth, soil permeability, leaching fraction (the amount of excess irrigation water applied to leach salts below the root zone), and groundwater salinity. A composite of these factors defines areas of probable salinity development.

Several thousand pieces of information can be entered into the computer for each map. Then computer programs written by Dennis L. Corwin, formerly with ARS, manipulate the information.

The programs analyze values assigned to each salinity factor. When these values exceed an assigned number, the computer indicates a potential trouble area.

Armed with these maps, farmers and growers will be able to locate areas on their land where salt problems are likely to occur. They can then change the way they farm to avert or reduce damage. Such damage, unchecked, would not only put farmers out of business, but could permanently destroy the agricultural productivity of the land.

Government agencies will be able to use the maps to anticipate the extent and degree of future salinity problems and formulate policy.

Land use planners will be able to find best locations for industrial, commercial, and housing needs, locating these on more salt prone areas.

In California's Imperial Valley, Rhoades records data as research assistant Porfirio Pacheco takes readings from an electromagnetic soil salinity monitor. (1185X1218-24)

Rhoades developed the measuring probe which contains four electrodes. An electrical current flows through the soil—passing between the outside pair of electrodes. A meter indicates how much resistance the current flow encounters—a direct indication of salinity. Each poke of the probe measures a soil sample roughly 6 inches deep and 6 inches in diameter.

Rhoades is also using a salinity monitor that may make measurements even easier. It consists of a generator that produces an electromagnetic field that emanates invisibly from a 3-foot-long bar. This field causes an electric current flow within the soil that is proportional to salinity. With such electronic measuring devices, Rhoades determines how salty the soil is. As soil salt increases, the secondary current flow increases proportionally.

"I don't even have to lay the monitor on the soil. It gives a correct reading when suspended at hip height. And by rotating the magnetic field, I can determine salinity at specific depths."

"The ideal measuring device might be some form of this electromagnetic measurer. It is possible, in principle, to mount it on an all-terrain vehicle or even suspend it from a low-flying aircraft. This would dramatically reduce the time and labor needed for data collection," Rhoades says.

McRae prepares a computer-generated map to identify irrigated land with potential salt problems. (1185X1217-11A)

"We're fairly confident with our present measuring devices and computer programs. Our biggest challenge will be matching our data with exact locations where we collected it," says Rhoades. He envisions someday using portable "direction finders" capable of receiving LORAN-type navigational radio beams either directly or relayed via satellite stations. Such systems are used commercially to aid ocean

Salt-laden wastewater flows from irrigated land in California's Imperial Valley into the Salton Sea (background). (1185X1220-15)

Christopher Colancino, research assistant at the University of California, Riverside, checks soil moisture and salinity for corn plants grown in a special container, called a lysimeter, to test the feasibility of reusing irrigation wastewater. (1185X1216-30A)

vessels and aircraft in routine navigation and to locate them in emergencies.

Strategy To Reuse Salt-Laden Water

"Not only are we concerned about reducing consumption of expensive water that could be better used for irrigating salt-sensitive crops and for urban and industrial demand, but we want to ensure that drainage water is not wasted, does not cause a disposal problem, nor that it become a source of pollution," Rhoades says.

He is referring to a potentially valuable resource—the excess water that drains from the state's $12 billion worth of irrigated crops each year. California may be generating upwards of 1.6 trillion gallons of subsurface drainage water annually—an amount of water roughly equal to what residents in New York City, Chicago, and Los Angeles use in 3 years.

Rhoades calculates that up to 70 percent of this can be reused. His approach to salvaging this water is to irrigate salt-sensitive crops with fresh water from wells and canals, then recycle what normally runs off as drainage water onto salt-tolerant crops.

He has already demonstrated that drainage water, now considered a waste because it has picked up salts as it flows down through soils, can be reused for irrigation. Some irrigators consider water containing more than 2,000 parts per million (ppm) salt too saline for crops. He successfully used water containing up to 6,000 ppm—one-sixth the salt concentration in sea water—to grow normal yielding crops.

With conventional irrigation, the amount of water that is applied depends on what crop is being grown, how old the plants are, and how hot the weather is. And irrigators must add to that amount enough more to keep water flowing downward so that salts accumulating in the soil are carried away from crop roots.

A new crop rotation strategy to use such brackish water for irrigation was the key element that Rhoades and cooperating researchers developed over the past few years at the U.S. Salinity Laboratory. They have three crop rotations under study.

The first rotation is wheat (a crop having intermediate salt tolerance), sugarbeets (a salt-tolerant crop), and then cantaloups (a salt-sensitive crop). These crops are being grown during a 2-year cycle in California's Imperial Valley.

Colorado River water, which contains about 900 ppm of salt and is considered good quality water, was used to saturate the soil before planting wheat and sugarbeets and for early irrigation. This water was also used for all irrigations of the melons.

The remaining irrigation water, for about the latter three-fourths of the growing season for wheat and sugarbeets, was drainage water containing about 3,500 ppm of salt. This water, if spread to a depth of 1

At the Imperial Valley Conservation Research Center in Brawley, CA, technician Robert Swain checks melons grown on land previously irrigated with salty wastewater. (1185X1219-6)

foot on the land and left to evaporate, would leave behind about 5 tons of salt per acre.

Another rotation tried in the Imperial Valley was cotton (a salt-tolerant crop) for 2 years, wheat for one season, and then alfalfa (a salt-sensitive crop) for several years.

All crop yields in the two studies thus far have been equal to yields from identical rotations that were irrigated with only fresh Colorado River water.

Cotton yielded an average 2.5 bales per acre, wheat 3.7 tons per acre, and sugarbeets 32 tons per acre.

The salt-containing drainage water made up 82 percent of the irrigation water applied to sugarbeets. For wheat, the percentage was 76, and for cotton it was 54.

Melons yielded 385 pounds of seed per acre on fields that had previously been irrigated with salty water for wheat and sugarbeet production. This yield equaled that from fields irrigated with only good water.

"The high melon seed yields indicate that even though salty water had been applied and was in the soil beneath their roots, proper irrigation management can restore these fields so salt-sensitive crops can flourish," says Rhoades.

The third experiment was on land in California's San Joaquin Valley, where saline ground-water exists in places just 2 to 3 feet below the soil surface.

Despite such an adverse environment, cotton and sugarbeet yields have been good—2.3 bales and 28 tons per acre, respectively—when irrigated with drainage water containing 6,000 ppm salt. Cotton and sugarbeets grown with California Aqueduct water containing 300 ppm salt yielded about a half bale more cotton but no more beets than the drainage water.

While these field studies continue, additional work is underway in the laboratory. A computer simulation model is being developed that Rhoades hopes to use for answering "What if. . ." questions such as "What will corn yield if a farmer applies water containing 3,000 ppm salt for 3 years?" or "How much fresh water with only 300 ppm salt must be applied to cropland that has been irrigated with drainage water before I can plant melons?"—**Dennis Senft,** Albany, CA.

James L. Rhoades is at the U.S. Salinity Laboratory, 4500 Glenwood Drive, Riverside, CA 92501. Jan van Schilfgaarde is now Director, Mountain States Area, 2625 Redwing Road, Fort Collins, CO 80526. ■

Rhizomania Threatens Sugarbeet Industry

Plant pathologist James Duffus examines sugarbeet leaf for evidence of disease. (1082X1251-20)

The race is on—scientists versus rhizomania. Time is on the side of rhizomania.

Sometimes called "bearded root" because heavy growth of root hairs on the main taproot lends a hairy look, rhizomania is caused by a virus known as beet necrotic yellow vein. It is so named because in severe stages it causes yellowed or dead tissue in the leaf veins.

Rhizomania was first discovered in 1983 near Paso Robles, CA. Its devastating presence was confirmed in 33 fields containing about 2,500 acres. A year later, rhizomania had spread to 71 fields containing more than 6,000 acres and moved to other sugarbeet growing areas of the state. California is the nation's second largest sugarbeet producer.

Typically, rhizomania causes losses of 20 to 50 percent in infected fields and has been known to cause total crop failure. Sometimes plants will have good bulk growth but contain only 3 to 4 percent sugar content—much less than the 14 to 18 percent in normal sugarbeets.

The rhizomania virus may have been present in this country for some time before it was identified, according to an Agricultural Research Service scientist. Such symptoms as do occur in top growth—a mild yellowing of leaf veins or some wilting in extreme cases—may go unnoticed because they are similar to those associated with a plant food deficiency or lack of water. The fungus *(Polymyxa betae)* that transmits it was discovered in 1976 and has since been found (without the virus) in Kansas, Nebraska, and several Canadian provinces.

James E. Duffus, a plant pathologist at Salinas, CA, working on the rhizomania situation, says there is no known way to control the disease once a field is infected. Evidence indicates that it is practically impossible to totally disinfect the field by chemical or cultural means.

"Because the disease attacks the roots," Duffus says, "unless growers periodically dig some plants to check them, they won't know if beets are infected until almost harvest time. By then, they will already have invested about $600 per acre in fertilizer, irrigation water, and other inputs."

Duffus believes that the only long-term solution to the rhizomania problem may be resistant sugarbeet varieties. Robert T. Lewellen, a plant geneticist at Salinas, is screening both cultivated lines of sugarbeets and some of the sugarbeet's wild relatives for resistance. Of the 100 or so lines tested so far, 3 or 4 appear to be less susceptible to rhizomania. It is also known that *Beta maritima,* the wild parent of all cultivated sugarbeets, has some resistance.

"The problem is we do not know the nature of this resistance; that is, whether it is resistance to the fungus or the virus, or if it is just varying levels of tolerance to either the fungus or the virus," Lewellen says.

If a source of high resistance can be found that will provide a solid foundation for resistance breeding, Lewellen says, "resistant commercial varieties are a possibility within 8 years; if not, then we are looking at 10 to 20 years."

In addition to the more long-term approach through selective breeding, Duffus' research plans include development of a quick soil test that can be used in the field to determine if the fungus or virus is present.

Until such a test is available, soil samples must be checked by bringing them into a greenhouse and planting sugarbeets in them. After about 4 weeks of growth, the young sugarbeet plants are pulled and assayed for rhizomania infection. A direct soil test would eliminate the time and effort required for greenhouse work and help growers avoid planting in infested fields.

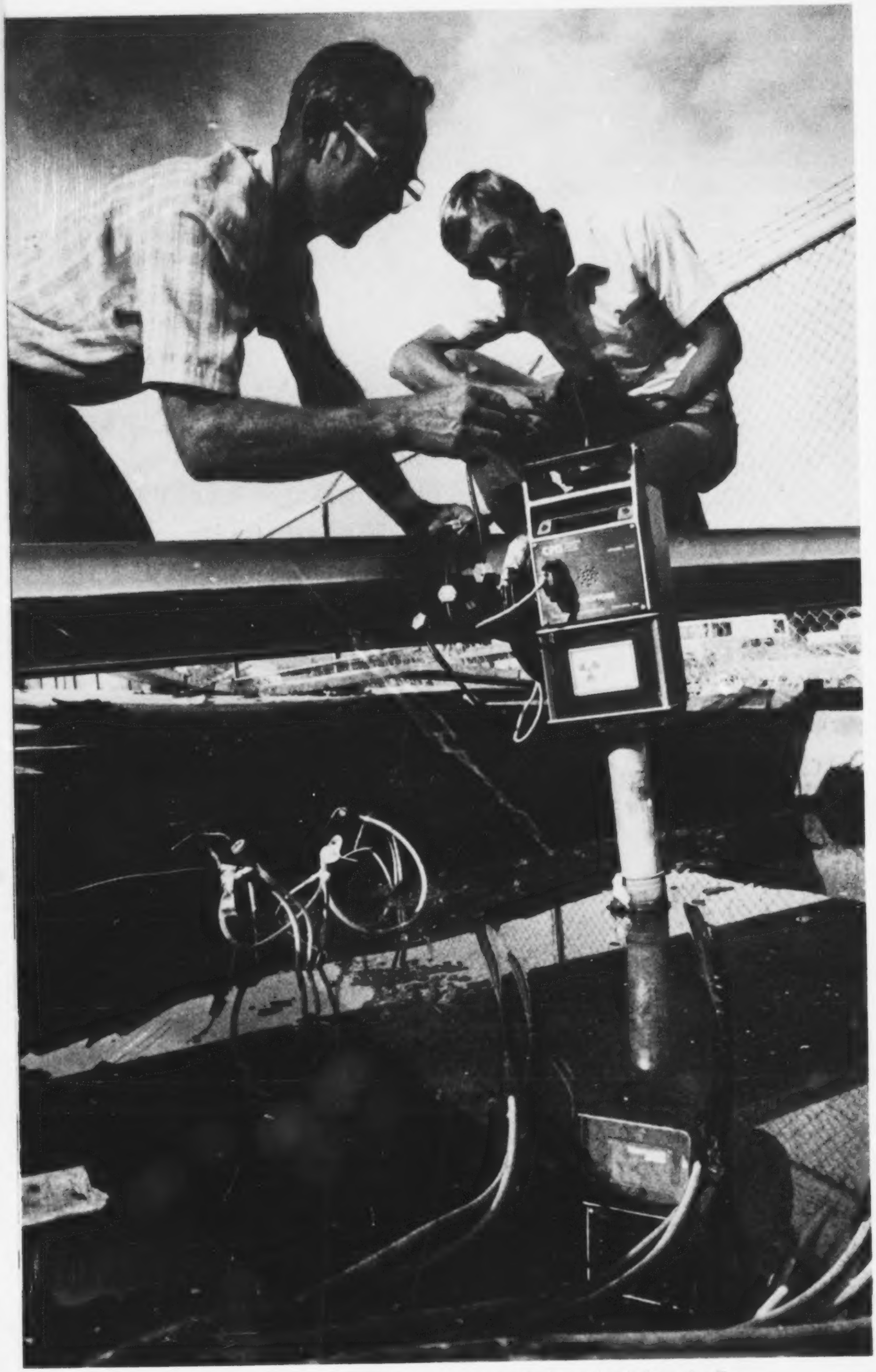
A second research aim is to learn more about the fungus that carries the rhizomania-causing virus. Some parts of the puzzle are known already. For example, rhizomania occurs most commonly when several things happen at the same time—the fungus and virus are both present, there is a relatively high soil temperature (68°F or 20°C and higher) over an extended period of time, soil moisture content is high, and soil pH is neutral to slightly alkaline.

The fungus that transmits the virus is moved by water through irrigation systems, by reuse of excess irrigation water after it drains from a field, by use of wash water from beet-processing plants for irrigation, by movement of beets from one growing area to another area for processing, and through movement of harvesting equipment from farm to farm.

Until resistant varieties are available, efforts should be made to prevent the spread of the fungus from one field to another.—**W. Jim Whorton,** Albany, CA.

James E. Duffus is in USDA-ARS Sugarbeet Production Research, U.S. Agricultural Research Station, 1636 East Alisal St., Salinas, CA 93905. ■

Groundwater Movement Studied



Using a neutron moisture probe, agricultural engineer Robert Rice (left) and soil scientist Robert Bowman monitor soil water changes during irrigation of one of their test plots. Tubing leads to soil water samplers placed at various depths. (0985X1013-15A)

Agricultural Research Service scientists in the West are tracing the paths by which irrigation water, along with any dissolved chemicals, takes shortcuts, bypassing part of the water already in the soil.

A separate study in Ohio shows that a single field application of a soluble chemical can raise chemical concentrations in groundwater for years.

Agricultural Research Service scientists in Phoenix, AZ, have timed the downward movement of water with chemical tracers and found rates faster than predicted by a commonly used procedure.

Robert S. Bowman, the ARS soil scientist who conducted the tests, used potassium bromide and four other chemicals to trace the percolation of water applied to test plots. With help from ARS agricultural engineer Robert C. Rice, he measured the chemical tracers at seven depths, down to 10 feet, to see how fast water moved.

On the average, the water moved more than 60 percent faster than previously calculated.

Intrigued by this finding, Rice extended the study to a 1½-acre field at the University of Arizona's Maricopa Agricultural Center. The results were even more striking—water moved up to six times faster than expected.

Bowman says, "How much new water bypasses old water is undoubtedly related to physical properties of the soil and subsoil, including how much sand and gravel are present. Another factor is the amount of water applied. The more water, the deeper the penetration of new water."

Bowman says information about water movement is important because chemical residues may move with the water, increasing the risk of contamination of groundwater supplies. Groundwater provides drinking water for an estimated 50 percent of the country's population. In addition, 40 percent of agricultural irrigation relies on groundwater supplies.

"The future of our groundwater," Bowman warns, "depends heavily upon our present management practices. This research shows the urgency of developing and refining those practices."

Herman Bouwer, director of the U.S. Water Conservation Laboratory in Phoenix says, "In the past, preferential flow of water through soil has been thought to be mainly associated with cracks, root holes, or worm holes. Our work shows that such flow can also occur in soils without large, obvious pores. This sheds new light on how fast chemicals move to groundwater and how predictions of such movements can be improved."

Bouwer says his laboratory staff will continue studies aimed at evaluating effects of irrigated agriculture on groundwater quality and recharge rates.

The research program has been expanded to include measuring the movement of chemicals, such as pesticides, which are carried downward with the recharge water.

In Beltsville, MD, scientists are monitoring the movement and fate of herbicides commonly used with no-till farming. Charles S. Helling, a soil scientist at the Pesticide Degradation Laboratory, says he has found that at least some fraction of the herbicides seem to move a lot faster than expected.

Since 1983, Helling and T.J. Gish, a soil physicist at the Hydrology Laboratory, have been sampling soil and groundwater on 15 no-till corn plots. The soil is typical of Coastal Plain stream valleys, with layers of clay, sand, and gravel.

On a separate tract of land, Gish is using bromide tracers to test the feasibility of predicting chemical movement in bare soils as well as those with crops.

In related research at the U.S. Salinity Laboratory in Riverside, CA, soil scientist Rien van Genuchten is modifying current models that predict chemical movement in soils to account for the preferential pathways that speed chemical movement. Van Genuchten is a cooperating University of California scientist.

William F. Spencer, an ARS soil scientist at the University of California at Riverside, has developed a model that traces all possible routes pesticides might take. Spencer developed this model in cooperation with scientists at the University of California.

Whatever route they take, once chemicals reach the water table they may stay there for a long time.

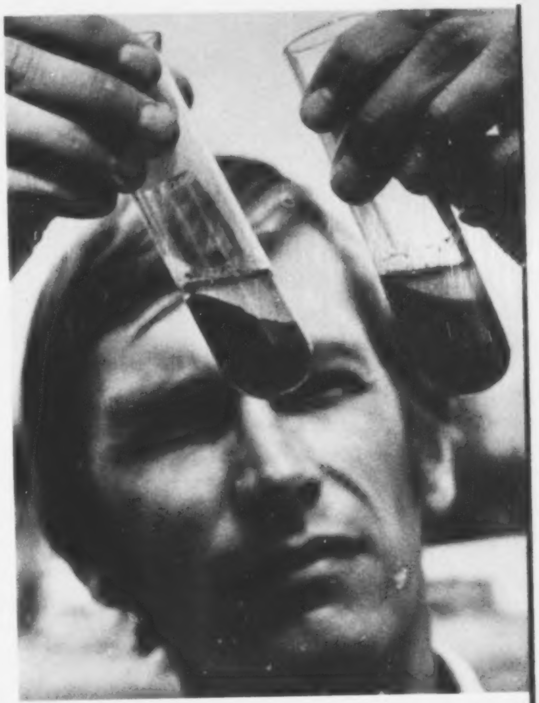
Soil scientist Lloyd B. Owens came to this conclusion after using potassium bromide to trace what happens to the nitrate form of nitrogen fertilizer after it is applied. Owens used bromide instead of nitrate because it moves through the soil much like nitrate and it is easier to trace.

Owens applied the bromide at the same rate commonly used to apply nitrate on pastureland. He found peak concentrations 21 to 24 months later in groundwater samples collected from springs supplied by the test watershed, and there was no significant decrease in concentration after 4 years.

To the farmer, lost nitrogen fertilizer is lost dollars. But the results of this research have broader implications because nitrate is considered a pollutant at high concentrations.

Owens says, "If more nitrate is applied than the plants can utilize, the impacts may be seen for several years. This study indicates that even a single application of a soluble chemical can have a multiyear influence on the quality of ground and surface water."—**Dennis Senft,** Albany, CA, and **Betty Solomon,** Peoria, IL.

Herman Bouwer, Robert S. Bowman, and Robert C. Rice are at the USDA-ARS U.S. Water Conservation Laboratory, 4331 East Broadway Road, Phoenix, AZ 85040. Lloyd B. Owens is in USDA-ARS North Appalachian Experimental Watershed Research, P.O. Box 478, Coshocton, OH 43812. ■



Top: Bowman checks soil and water samples that will be analyzed to determine concentrations of chemical tracers extracted from the soil. (0985X1013-30A)

Above: Technician Gladys Hauer and Bowman prepare to analyze samples with high-performance liquid chromatography. The technique allows measurement of up to seven different tracers simultaneously from a single sample. (0985X1012-30)

Temperature Integrator Reduces Spraying

A battery-operated device that measures heat from the sun may tell apple growers when it's time to spray for codling moths.

J. Franklin Howell, an Agricultural Research Service entomologist in Yakima, WA, developed the device—a temperature integrator—to monitor temperatures in orchards and provide cumulative degree-hour readings, much like an electric meter records kilowatt hours of electricity used.

"Precise timing is the key to effective spraying," says Howell. If the orchards are sprayed too early in the spring, pesticide effects wear off before the moths have completely emerged. If the spray goes on too late, larvae can enter the fruit where they are protected from pesticides. The codling moth is a major pest in apple orchards everywhere, especially in the West.

The system to determine spray times for codling moths consists of a temperature meter, or integrator, and a series of traps baited with chemical sex attractants (pheromones) placed throughout the orchard. The pheromone traps let the grower know when adult codling moths first begin to appear—usually about the end of apple blossom bloom. As soon as the first moth is trapped, the grower turns on the temperature integrator, which begins accumulating degree-hours. At about 2,000 degree-hours Celsius, the first codling moth egghatch should occur.

Correctly timed sprays will kill all adults and larvae that have emerged to that point as well as all adults that emerge from then on until the spray wears off, about 20 days later.

Howell says temperature integration can save growers up to 35 percent of their present cost of controlling the pest. It can eliminate time-consuming and—literally—fruitless spraying as well as the harm unnecessary spraying does to beneficial insects. Besides improving codling moth control in apple orchards, Howell says that a similar system could be adapted for use on other crops.—**Howard Sherman,** Albany, CA.

J. Franklin Howell is located at the Yakima Agricultural Research Laboratory, 3706 West Nob Hill Boulevard, Yakima, WA 98902. ■

Freeze-dried Seeds Really Last

When Lowell Woodstock returned to Beltsville in 1978 after 2 years in Saudi Arabia, he found that all the freeze-dried onion seeds he had left from earlier freeze-drying experiments were still viable, while more than half the air-dried seeds were not.

Agricultural Marketing Service seed analyst Susan Maxon prepares seeds for freeze drying. The original 1976 research was a joint ARS-AMS project. (1185X1321-18)

Woodstock, a plant physiologist with the Agricultural Research Service, kept the freeze-dried seeds for 7 more years of storage at room temperature and found little sign of deterioration.

The original research in 1976 showed that freeze-drying markedly improved storage life of onion, pepper, and parsley seeds at temperatures between 106° and 133°F (40° to 50°C). These temperatures are equivalent to those in the Tropics and subtropics.

Woodstock says freeze-drying works very well in combination with air-drying. First, seeds are air-dried to about 10 percent seed moisture and then freeze-dried down to about 5 percent.

Air-drying can easily reduce seeds to about 10 percent, but after that point it becomes difficult, requiring either high or prolonged heat, both of which can damage seeds.

Woodstock believes that onion seeds and possibly other vegetable seeds dried by this two-step method can be sealed in moisture-proof packets and stored for many years at room temperature or indefinitely at sub-freezing temperatures.

Lowell Woodstock is at the USDA-ARS Seed Research Laboratory, Bldg. 006, BARC-West, Beltsville, MD 20705. ■

New Detector for Hidden Injuries in Fruit

Invisible wounds caused by stress to fresh fruits and vegetables can be found with a new, rapid technique that measures delayed light being emitted from chlorophyll molecules.

The technique is designed to help reduce the estimated 20 percent of all fresh produce picked in the United States that never reaches the consumer, says Agricultural Research Service horticulturist Judith A. Abbott. It can spot injuries from excessive chilling, sunburn, or air pollution, before any visible signs appear.

To find these injuries, Abbott and ARS colleagues at Beltsville, MD, measure the delayed light emission (DLE) of produce by shining light onto green and yet-to-ripen fruits and vegetables, such as tomatoes or peppers, for 7 millionths of a second. A detector measures the light emitted several seconds later from chlorophyll molecules.

Chlorophyll molecules—where a plant converts the energy from sunlight to plant food—both absorb and later emit light. If the produce has been injured, the molecules absorb light but emit about 20 percent of the amount healthy produce does. This effect signals internal stress several days before the injury becomes obvious.

The DLE instrument measures extremely low light levels of less than 1 percent of what a human eye can see. Previously, scientists had to cut open produce in order to test for internal injuries.

Abbott is studying chilling injury because it is costly for food distributors. It is caused by keeping fruit too cold for too long. "Our problem is that we don't yet know what controls the breakdown of tissue in produce," says Abbott. The answers may lie in the cell walls and membranes of the produce, which are controlled by enzymes and hormones.

"If we know what chemical changes happen to the fruit during chilling, then maybe we can develop ways to prevent them," Abbott says. "Presently, DLE is used only as a research tool. It has potential to help decide when to pick produce in the field or how long to store it, but that probably won't be for years," Abbott says.—**Deborah Aksler,** Beltsville, MD.

Judith A. Abbott is at the USDA-ARS Horticultural Crops Quality Laboratory, Bldg. 002, Room 113, BARC-West, Beltsville, MD 20705.

10°C
Day 7 T21
2101-2112

Horticulturist Judith Abbott checks tomatoes for visible injury before making delayed emission test for invisible wounds. (1085X1202-13)

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

PATENTS

Sure Way To Diagnose Livestock Disease

More accurate diagnoses of bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV) may be on the way, thanks to antibodies produced by cloned hybrid cells.

These similar livestock diseases are sometimes confused by existing diagnostic methods. Agricultural Research Service scientists had earlier prepared hybrid cells which secrete monoclonal antibodies that identify only BTV. Now the picture is complete—cells have been prepared that secrete antibodies that identify the two EHDV types known to exist in this country without cross-reacting with any of the five known types of BTV.

Simple tests common to most diagnostic laboratories can be used to diagnose EHDV with monoclonal antibodies.

For technical information, contact M. Ann Whitehead, USDA-ARS, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705. *Patent Application Serial No. 06/708,613, "Monoclonal Antibodies to Epizootic Hemorrhagic Disease Virus Antigen."* ■

Curing Hides Faster

A fresh cattlehide preserved in just 1 hour, without salt, remained in excellent condition 6 days after treatment.

The hide was agitated in a drum with 20 percent butyl carbitol and 80 percent water for 1 hour at about 6 rpm and then allowed to drain. It was then stored in a plastic bag at room temperature.

This method has also been used to successfully preserve cattlehides with butyl carbitol acetate, diethyl carbitol, butoxy triglycol, and butoxy ethoxy propanol.

The preservative concentration can be reduced as low as 2 percent by adding an acid such as formic acid, a detergent/emulsifier, and an amount of water equal to 20 percent of the hide's weight.

Presently, cattlehides are preserved commercially by brining for about 12 hours with saturated salt solutions containing chemicals to kill microbes.

For technical information, contact William J. Hopkins, USDA-ARS, Hide Processing Research, 600 East Mermaid Lane, Philadelphia, PA 19118. *Patent No. 4,478,728, "Process and Compositions for Preserving Fresh Hides and Skins."* ■

Better Zinc, Iron, and Chromium Supplements

Just as picolinic acid in the body aids zinc absorption, artificial mixtures of the acid with zinc and other heavy metal salts produce dietary supplements that are more easily absorbed into the bloodstream.

Elemental metal and inorganic metallic salts have generally proven to be ineffective supplements, particularly for people with intestinal malfunctions that block absorption. Also, doses of one metal can cause side effects resulting from competition with other metals, and doses are often kept below the most effective amounts because of the metals' toxicity.

The picolinic acid-salt supplements avoid these problems because they are directly available for absorption into the system without competition from other metals, in the same form normally produced by humans.

For technical information, contact Phyllis E. Johnson, USDA-ARS Grand Forks Human Nutrition Research Laboratory, P.O. Box 7166, University of North Dakota, Grand Forks, ND 58202. *Patent No. 4,315,927, "Dietary Supplementation with Essential Metal Picolinates."* ■

How To Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

4/2

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 2, February 1986

Agricultural Research

Sorting Suspects

See page 7

RK PUBLIC LIBR
FEB 1 9 1986
U. S. GOVT. PUBS.
DEPOSITORY 378

77.12:

Research: Why Invest Now?

The 1970's view of a world unable to feed growing populations has given way to concerns about surplus production in many developed countries. Much of the rapid growth in output can be attributed to advancements spawned by scientific research, including changes in farm machinery, pesticides, and plant and animal genetics.

U.S. agricultural productivity is expected to grow 1.5 to 2 percent per year for the next 10 years. Output could increase 40 percent by the 1990's if these productivity gains are combined with the cropland currently idled and the gradual conversion of 20-30 million acres of land suitable for cropping but not now used.

Because of their traditional emphasis on expanding output, coupled with budget constraints, agricultural science and technology programs have come under increasing scrutiny.

The economic climate in the world poses several challenges to the traditional rationale for support of agricultural science and technology in developed countries. Why should governments and industry continue to fund agricultural research in the face of food surpluses, tight budgets, and falling demand? There are many good arguments for maintaining a strong agricultural science and technological capacity, including:

- *Maintaining productivity growth:* Growth in productivity and efficient use of resources are the primary means of improving the benefits to society. Increased productivity assures more output from available land, water, and other resources. If demand is not growing fast enough to absorb productivity gains, resources can be transferred from food production to other uses. By using fewer resources, costs and the proportion of society's income required to meet basic food and agricultural needs will be lower. In fact, if productivity levels in developed countries were the same as in 1950, food would take nearly twice its current share of disposable income.
- *Coping with declining supplies and rising costs:* The supplies of many resources including fertilizer, minerals, ore, petroleum, and nonrechargeable groundwater pools, are fixed. Eventually, agriculture must adjust to the loss of some of these resources or to their increasing costs as supplies dwindle.
- *Developing renewable raw materials:* Another side to the depletion of stock resources is the possibility of developing new uses for agriculture's productive capacity. One prospect is using agricultural products as renewable resources. Biomass fuels, such as ethanol, may eventually become more economical, and industries could turn to agriculture for other renewable raw materials. Agriculture could become proportionally less of a food industry and more a supplier of industrial raw materials. Such developments provide new opportunities for farmers and a way for the world to adapt to limited supplies of some stock resources. Agricultural research will need to play a lead role in the development of these new products.
- *Improving the quality of products and processes:* With food and fiber in plentiful supply in developed countries, there is an opportunity to shift the focus of some research to the quality of production. This includes research towards efficient use and conservation of resources. Other examples include increased energy efficiency; less ecologically damaging technology; techniques that makes more efficient use of water, mineral nutrients, and other limited resources; and foods that are tastier, more nutritious, and safer for human consumption.
- *Meeting the food needs of developing countries:* Despite excess supplies in most developed nations, many countries still suffer food shortages. The developed world has a vested interest in assisting the developing countries. Stronger economies for many of these nations, including the agricultural sectors, could improve chances for global political stability and greater market potential for the growing agricultural capacity of developed countries.
- *And maintaining flexibility to deal with an uncertain future:* Considerable uncertainty surrounds the scenario of plentiful food supplies, especially beyond the next decade or two. Unforeseen natural, economic, or political shocks could change the outlook. Without ongoing investment in science and education, continued productivity growth cannot be assured. With food security, it is preferable to err on the side of surplus rather than shortage.

[The above are excerpts from a statement by John E. Lee, Jr., Administrator of the Economic Research Service.—**Ed.**]

Agricultural Research

Cover: A collection of forest-devastating gypsy moths helps ARS entomologist Ronald Hodges identify specimens submitted to the Systematic Entomology Laboratory. The Laboratory is operated in cooperation with the Smithsonian Institution's Museum of Natural History where about 30 million specimens are stored in the National Insect Collection. Story begins on page 7. (1185X1256-4A)

p. 11

p. 12

p. 14

7 Name That Insect!

Millions of dead insect specimens flow through identification services around the United States each year. A large percentage of the toughest ID cases wind up at one federal laboratory in Washington, DC.

12 An Oilseed Crop With Promise

Taming the wild Cuphea could be an alternative to importing coconut and palm kernel oils to make soaps, lubricants, and industrial raw materials.

DEPARTMENTS

4 Agnotes

Aiming for a Chick's Genetic Blueprint
Meat Quality Forecast for Buyers
American Elm — More Than a Lone Survivor
Low-Salt Soy Sauce Tastes Just as Good
Screen Test for Bad-Acting Bees
Cultured Fibers Boost Cotton Gene Research

14 Technology

Electron Beam Shines Leather
Computer "Fingers" Grain Thieves

16 Patents

Double-Dip Keeps Papayas Fly-Free
A Better Way to Wrap Vegetables
Low-Salt Foods

Vol. 34, No. 2
February 1986

Editor: Lloyd E. McLaughlin
Assistant Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

John R. Block, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Aiming for a Chick's Genetic Blueprint

Ironically, the virus that causes avian leukosis may be used someday as a carrier for an inherited resistance to the disease.

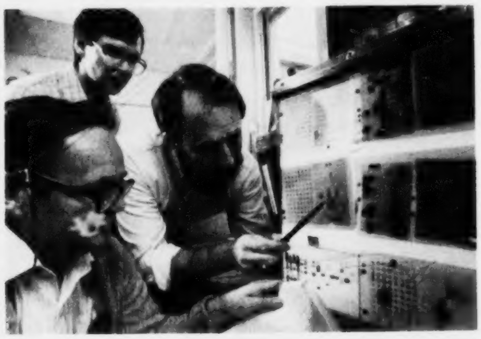
Although the tumor-causing disease kills only 1 to 2 percent of infected chickens, those that survive produce about 10 percent fewer eggs.

Viruses have already been used to carry genes into the chromosomes of plants and mice. But Lyman B. Crittenden, an Agricultural Research Service animal geneticist in East Lansing, MI, says no one has ever done this with chickens.

Crittenden says he and microbiologist Donald W. Salter and other colleagues are taking a first step toward adding desirable genes in chickens—inserting avian leukosis virus into the genetic material in the reproductive cells of fertilized chicken eggs so it will be passed on to future generations.

Crittenden says he has "very good preliminary evidence" that he will succeed.

The real proof comes after the injected eggs hatch, the chickens mate, and the new chicks are found to have inherited the virus genes.



Animal geneticist Lyman Crittenden (left), technician Kent Helmer, and microbiologist Donald Salter (right) evaluate autoradiograms of avian leukosis-infected chicken blood. Through these studies, Crittenden and his associates hope to identify chickens with avian leukosis genes in their DNA. (1185X1252-33)

If the first step succeeds, scientists will still face years of work before they can attach other genes to the virus for resistance to various chicken diseases or for rapid growth. One task they would face is deactivating the virus genes so they do not produce the virus.

Lyman B. Crittenden is at the USDA-ARS Regional Poultry Laboratory, 3606 East Mt. Hope Road, East Lansing, MI 48823. ■

Meat Quality Forecast for Buyers

A new test tells how long hamburger will stay fresh until it is finally sold in supermarkets or used in fast-food restaurants.

Ground beef sold in bulk can now be tested by buyers for restaurants, supermarket chains, and the military—before they buy—to quickly estimate the shelflife, says Agricultural Research Service chemist A. Douglas King, Jr.

The analysis is superior to other methods for detecting early spoilage of hamburger because it is less expensive, more accurate, and faster (it only takes 1 hour).

Further, it's more convenient. The test can be run on an instrument—a high-performance liquid chromatograph—that is readily available at most commercial laboratories, says King.

Other methods either take too long (one test takes 5 to 9 days) or for other reasons are impractical, according to King. He and former ARS researcher Patricia Nassos-Stalder developed the new technique.

The analysis measures lactic acid, a compound that occurs naturally in animals and is also produced by bacteria. High levels of lactic acid indicate the beef will spoil quickly.

King says buyers can use test results either to determine how much longer they can safely store the meat, or to reject the beef outright.

The test is used in the first stage of processing ground beef. The meat is coarsely ground, then kept refrigerated in large, oxygen-free plastic bags until needed, which may be as long as several weeks. (Later, when a supermarket or other outlet buys these "chubs" or "keeper" packs, the coarse grind is converted to the familiar "fine grind," which has a much shorter shelflife.)

Bacteria that produce lactic acid thrive in the oxygen-free pack, and—at low levels—are probably beneficial. But lactic acid can build up—if the beef is kept in oxygen-free storage too long—and can cause what's known as sour odor spoilage.

King and Nassos-Stalder have patented their invention.—**Marcia Wood,** Albany, CA.

A. Douglas King, Jr., is at the USDA-ARS Western Regional Research Center, 800 Buchanan St. Albany, CA 94710. ■

American Elm—More Than a Lone Survivor

Mass plantings of American elms set the stage for the Dutch elm disaster beginning in the thirties.

The fungus came from France, in wood shipped to the east coast. Within 4 or 5 years, scientists could retrace the wood's trip by looking at elm trees. The trail ran along railroad tracks to furniture factories in Cleveland and Columbus, OH.

Lawrence R. Schreiber, research leader of USDA's Agricultural Research Service Dutch elm disease center in Delaware, OH, has spent 25 years searching for survivors with genes for a strong resistance to the fungus.

Schreiber and his colleagues search for trees on their own and sometimes get calls from people with an ancient survivor in their yard.

When a tree is selected for

When photographed in 1960, stately American elm trees formed a shady canopy over this flagstone walk on the campus of Pennsylvania's Swarthmore College. Several years ago, Dutch elm disease destroyed all but a few of these trees. (Photograph by Grant Heilman)

study, the scientists send someone to cut fresh shoots as near the top as possible, sometimes using an especially high-reaching cherry picker.

When they return to the lab they try to get the shoots to root. Then the shoots that do grow are deliberately inoculated with Dutch elm disease fungus to find out if this tree was really special or just another lucky one.

Schreiber says it's not uncommon to find a single elm surviving by chance where others have died. Nor has the American elm gone the way of the American chestnut. Schreiber estimates there are still hundreds of thousands to millions of American elms growing in this country.

So far, all but a handful of those tested have turned out to be just lucky, with no genetic resistance. Even those with resistance do not measure up to European and Asiatic elms, which have genes for strong resistance.

The Ohio lab has released three selections of elms resulting from breeding work with European and Asiatic elms, led by plant geneticist A.M. Townsend. In 1984, Townsend and the breeding part of the Dutch elm program moved to the U.S. National Arboretum in Washington, DC.

Why not cross the American elm with its resistant European and Asiatic cousins? It's impossible, Schreiber says, because the American has double their number of chromosomes.

That's why Schreiber is considering bypassing conventional breeding by fusing protoplasts (cells without walls) from the American elm with other resistant species.

Until an American elm is released for sale, people will have to settle for European and Asiatic elm varieties adapted to look more like the American elm.—**Don Comis,** Beltsville, MD.

Lawrence R. Schreiber is at the USDA-ARS Nursery Crops Research Laboratory, 359 Main Road, Delaware, OH 43015. A.M. Townsend is at the USDA-ARS National Arboretum, 3501 New York Ave., NE, Washington, DC 20002. ■

Low-Salt Soy Sauce Tastes Just as Good

Removing salt from soy sauce and similar foods can help people who like these foods maintain the correct ratio of sodium to potassium in their diets.

Tests of a new process show the sauce retains its rich flavor after sodium content is cut 50 percent and potassium is increased as much as five times, says Wayne Camirand, an Agricultural Research Service chemist at Albany, CA. He now has a patent for the invention. (See page 16.)

The technique comes at a time when Americans are not only continuing to get about twice the recommended amount of salt but are also not getting the proper balance of potassium to sodium. The recommended ratio for these two minerals is about two to one (twice as much potassium to sodium) but many people get just the opposite—too much sodium in relation to potassium.

High salt intake has been linked to high blood pressure (hypertension), a condition that affects one out of every five Americans over age 25. Imbalances in the body's potassium-sodium supply may contribute further to this condition.

The new technique works "not only for soy sauce but for other high-salt, fermented liquids as well, including oriental fish sauce and tamari sauce," says Camirand.

The process is simple and inexpensive: A stream of sauce is forced through a series of curved channels; alongside it, a stream of potassium chloride solution is pumped in the opposite direction.

The two flows are separated by a special barrier which allows cations (positively charged particles) of sodium to move out of the soy sauce and into the potassium. Similarly, potassium cations can flow from their solution into the sauce. All other particles are blocked.

The exchange can be interrupted when the mixture reaches the desired level of sodium but still retains a distinctive soy flavor. Sauce that's too low in sodium probably won't pass taste tests; a blend too high in potassium has the natural bitterness of this mineral.

Salt is needed to kill any harmful micro-organisms that might develop during the long, slow fermentation process. Later, the salt serves as a preservative. Potassium interferes with fermentation, so can't take the place of salt during that stage. However, once the sauce is fermented, potassium can substitute for sodium as a preservative.—**Marcia Wood,** Albany, CA.

Wayne M. Camirand is at the USDA-ARS Western Regional Research Center, 800 Buchanan Street, Berkeley, CA 94710. ■

Screen Test for Bad-Acting Bees

A 1-minute screening of wing size in a field laboratory can tell a honey bee from an Africanized bee.

Agriculture inspectors are already using the test in California, where a swarm of Africanized bees (sometimes called killer bees) was found for the first time in the United States.

Wing measurements give biological aide John Hogen, Bioenvironmental Bee Laboratory, Beltsville, MD, a way to quickly spot Africanized bees, so-called "killer bees." (0985X958-21)

The California Department of Food and Agriculture and USDA's Animal and Plant Health Inspection Service are testing about 10,000 commercial hives in that state.

Officials elsewhere can use the test to make sure Africanized bees are truly on the loose before they risk eliminating bee colonies, says inventor Thomas Rinderer. Rinderer is research leader of the Agricultural Research Service's Bee Breeding and Bee Stock Laboratory, Baton Rouge, LA.

Rinderer noted that officials want to protect domestic honey bees, which closely resemble Africanized bees, because they are vital to American agriculture. Over $18 billion worth of crops are pollinated by honey bees every year.

Africanized bees received their bad name because they are far more aggressive and likely to sting than domestic honey bees, although they do not have a sting that is any more toxic.

Rinderer and colleagues are using the new test at the Baton Rouge laboratory to identify samples shipped from California.

Bees are first screened in a 1-minute procedure: The forewings of 10 randomly selected bees from a suspect colony are mounted on slides, projected onto a screen, and measured.

Wing sizes are then checked against a numbered chart that has pre-established measurements for each kind of bee.

However, if there is still a suspicion that the bees are Africanized, further testing begins.

First, the researchers weigh the bees and measure their hind wings and legs. Next, they enter data on all the measurements into a computer, which then gives a figure indicating the probability that the bees are Africanized.

"We call the test FABIS (Fast Africanized Bee Identification System) and it can be taught to state and local technicians in only 1 day," says Rinderer.—**Jessica Morrison,** formerly at Beltsville, MD.

Thomas E. Rinderer is at the USDA-ARS Bee Breeding and Bee Stock Laboratory, 1157 Ben Hur Road, Baton Rouge, LA 70820. ■

Cultured Fibers Boost Cotton Gene Research

For the first time, cotton fibers have been grown in the laboratory directly from cells without growing any other part of the plant.

In the spring of 1985, a team of scientists at Texas Tech University, Lubbock, who were trying to grow whole cotton plants from cells in a nutrient solution, found that some of the cells had become cotton fibers.

The Agricultural Research Service, which partially funded the Texas Tech research, suggested further work to improve the nutrient solution so more cells would become fibers. The scientists have now patented a medium that induces most cells to develop into fibers.

An early beneficiary of this finding will be the recently established Cotton Quality Regulation and Alteration Research group at the ARS Southern Regional Research Center in New Orleans, LA.

Members of the new unit, including plant molecular biologist Barbara A. Triplett, will work closely with other scientists at the Center doing cotton fiber research.

Triplett says the research team will seek a basic understanding of how fiber forms. She says the cell culture technique will make this work much easier since the group will have a constant supply of cells all performing the same biochemical processes.

One of the first tasks, she says, will be to find out if the fiber formed from cells is the same as that formed in cotton plants.

Triplett stresses that she can see no commercial potential to growing cotton in a laboratory rather than a field. She says it's very expensive and the yield is low.

Rather, she sees the technique as a research tool to learn enough about fiber to be able to genetically alter it and eventually improve its quality.

The textile industry would like to have cotton fibers that are longer, stronger, of uniform size, and with properties that will help processing, including dyeing and finishing for permanent press fabrics.—**Don Comis,** Beltsville, MD.

Barbara A. Triplett is at the USDA-ARS Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179. ■

Name That Insect!

On August 1, 1983, Michael P. Malone of the FBI Laboratory in Washington, DC, hand-carried a plastic vial containing several insect specimens across the Mall to the Smithsonian Museum of Natural History building. He was bringing them to the Agricultural Research Service's Systematic Entomology Laboratory (SEL) to determine whether they were native to the United States or of foreign origin.

A few days earlier, the FBI had been called in on a $2.9 million electronics theft. Twenty-six cartons of integrated circuits airshipped from an assembly plant in Malaysia through San Francisco airport to several destinations in the western United States had been broken into. The insects, a few pieces of wood to add weight, some substituted packing material, and a soil sample were the only clues.

SEL's Robert V. Peterson distributed the dead specimens—a fly, a biting midge, and two ants—to the appropriate entomologists for identifications.

The fly was too badly mashed to determine its homeland. The ants proved to be a common species that could have invaded the boxes anywhere between Malaysia and their final destinations. But the biting midge was identified as a species common to Asia and unknown in California. The identification, together with the FBI lab's finding that the wood was not native to America, pointed to Malaysia as the probable site of the theft, according to Malone.

The roots of the Systematic Entomology Laboratory (SEL) go back before 1862 when Congress established the Department of Agriculture and provided for an official entomologist. Now part of USDA's Agricultural Research Service, the laboratory has 28 entomologists, 9 technicians, 5 artists and clerks, and 5 dedicated retirees who continue their own research and help with the 170,000 insect and mite specimens that are sent to the laboratory each year for identification.

To identify a butterfly, entomologist Mike Schauff selects comparison specimens from the more than 4 million specimens of Lepidoptera stored in approximately 35,000 drawers in the National Insect Collection. (1185X1257-33A)

Most of the staff is housed at the Smithsonian museum, while 6 entomologists and laboratory chief Douglass R. Miller have their offices about 15 miles away at the Beltsville (MD) Agricultural Research Center.

Raymond J. Gagne, SEL's specialist in flies that lay their eggs in dead animal tissues, is sometimes called on by the FBI or state and local police to estimate the time of death of a suspected murder victim. Different species of flesh flies will invade a body at different stages of decomposition, he explains, and the larvae of each species develop at predictable rates. His reports generally corroborate the medical examiner's, he says.

Playing detective is only a small part of Gagne's work. He estimates he receives about one ID request per month to support criminal or civil investigations but spends about one-quarter of his time on ID's for research and quarantine.

The rest of his time is devoted to his own research on gall midges—there are about 1,000 known species in North America alone.

How does one become so skilled at distinguishing insect species? By the science of taxonomy—the classification of organisms in an ordered system designed to indicate natural relationships.

Taxonomists find differences in gross characteristics—size, shape, coloring, sculpturing on the body, arrangement of veins in wings—and internal differences, particularly in the genital organs. "With some parasitic wasps," says entomologist Paul M. Marsh, "this is quite a task. The specimens are often as small as the head of a pin."

The tools of a taxonomist's trade have traditionally been a collection of specimens, a reference library, a light microscope, and drawing implements, but SEL scientists also use a scanning electron microscope that produces three-dimensional photos and a computer-assisted image analyzer to make and compare minute measurements of

15KV WD 16MM

Entomologist Paul Marsh chooses highly detailed scanning electron micrographs of parasitic wasps to illustrate an identification manual. (1285X1375-9)

Above, top: Larvae shipped from a Florida hospital to the Systematic Entomology Laboratory are examined by entomologist Robert Peterson (foreground) and retired entomologist George Steyskal. As Florida doctors suspected, the larvae are intestinal parasites of the Psychodidae family (moth fly). The moth fly can give people leishmaniasis, a tropical disease which eats away at flesh. (1285X1361-33)

Above: After extracting resin midges from a pine twig, entomologist Raymond Gagne will examine them under a microscope for more positive identification. Resin midges destroy conifer seeds, causing expensive losses in areas set aside for seed production. (1285X1345-26)

Above: Because individual species of crickets and katydids often appear so similar to one another, entomologist David Nickle confirms identifications by recording and analyzing their mating songs. (1285X1354-14)

insect parts, such as veins in the wings of Africanized bees. The image analyzer is similar to a machine used by police for high-speed identification of fingerprints.

ARS entomologist Akey C.F. Hung, who works with SEL entomologists, is delving into insect cells with a gas chromatograph, looking for chemical "fingerprints" among the chromosomes and enzymes that can be used to sort insects into their evolutionary slots.

In addition, taxonomists rely heavily on field entomologists to supply information on an insect's habitat, its seasonal distribution, its preferred hosts—whether plant, animal, or other insects—and any other helpful information. You might say the taxonomist provides the "charcoal sketch," while the field workers provide the "modus operandi."

In the case of crickets and katydids, it's the mating song that confirms their identity. According to entomologist David A. Nickle, individual species often appear so similar to one another that they are difficult to identify through observation alone.

Nickle keeps live insects in his lab and works with a tape recorder. "The males call their mates by rubbing their wings together," he explains, "and each species has a distinctive song depending on how fast the wings vibrate." In fact, he has become so adept at mimicking the males of one species of katydid that the females flock to him.

Nickle and his SEL colleagues operate on an annual budget of about $2 million and quietly chip away at their prodigious task: to develop classification systems for insects and mites important to agriculture and to develop a storage and retrieval system for the mass of information accrued over the 100-plus years USDA has been gathering it.

The combined USDA-Smithsonian library is among the most complete reference libraries on systematic entomology in the world, says Lloyd Knutson, director of the institute that oversees the SEL and one of the 28 entomologists himself.

In return for office space at the Museum, the staff curates three-fourths of the Museum's entomology collection—more than 25 million insect and mite specimens. Each year, they add about 50 thousand of the specimens that come in for identification to the Smithsonian's permanent collection.

In addition, the SEL laboratory is computerizing a catalog of North American beetles, another of the 100,000 flies of the world, and a complete profile of each of the estimated 3,000 insects, mites, and related arthropods that have immigrated to North America. Much of the information for the Western Hemisphere Immigrant Arthropod Database is scattered throughout the continent in private and public collections and in unpublished records and will have to be gathered before entering in the database.

The scientists rely on this vast reservoir of information to provide the identification service—the sole federal unit providing such a service.

Millions of dead insect specimens flow through various identification services around the country each year. A large percentage of the toughest ID cases eventually wind up in the SEL, says Knutson.

A handful of specimens make their own way into the Museum . . . uninvited, says entomologist John M. Kingsolver. He has identified several species of dermestid beetles that are gnawing away at the insides of animal exhibits. The beetles have also collapsed the leather seat of an ancient sedan chair and were found invading a mummy on the second floor.

From his sixth-floor office overlooking the Mall, Kingsolver has also helped to probe antiquity. He identified a 1,900-year-old beetle that had been preserved within a haystack at

Along with Systematic Entomology Laboratory Chief Douglass Miller (right), Lloyd Knutson, director of the Biosystematics and Beneficial Insects Institute of which SEL is a part, examines computer printouts from one of the Institute's many databases—in this case, a catalog of flies of the world. (1285X1360-9)

an archaeological site near Naples, Italy. The site was buried by the same volcanic eruption that covered Pompeii.

Except for the few unusual requests, SEL entomologists concentrate on agriculturally related identifications. Users of this service are involved in biological control, ecological studies, and other research, extension, and regulatory activities of government agencies and private organizations.

A major user is a division of USDA's Animal and Plant Health Inspection Service which is responsible for keeping alien insects out of the United States and for tracking the movement of pests like the gypsy moth within its borders. Inspectors stationed at every port of entry thoroughly inspect each foreign shipment for possible stowaways. If they find any species on their "wanted" list, they have the cargo fumigated before it touches U.S. soil. But fumigation is costly to the shipper. When there is some question on an insect's identity, the specimens are rushed to the SEL via express mail for positive identification.

Every day in port costs the shipper money, particularly when the cargo is fruit or flowers. But the loss is miniscule compared to the havoc an alien insect can wreck once inside this country. Immigrant species—the boll weevil, for example—are responsible for about half of the insect-caused losses to U.S. agriculture.

Entomologist Donald M. Anderson leads the lab in *urgent* ID's, handling half of the more than 2,000 urgent requests each year. He specializes in bark beetles and beetle larvae, which are often found in imported lumber and wood products as well as on the packing crates and pallets used for shipping just about any commodity.

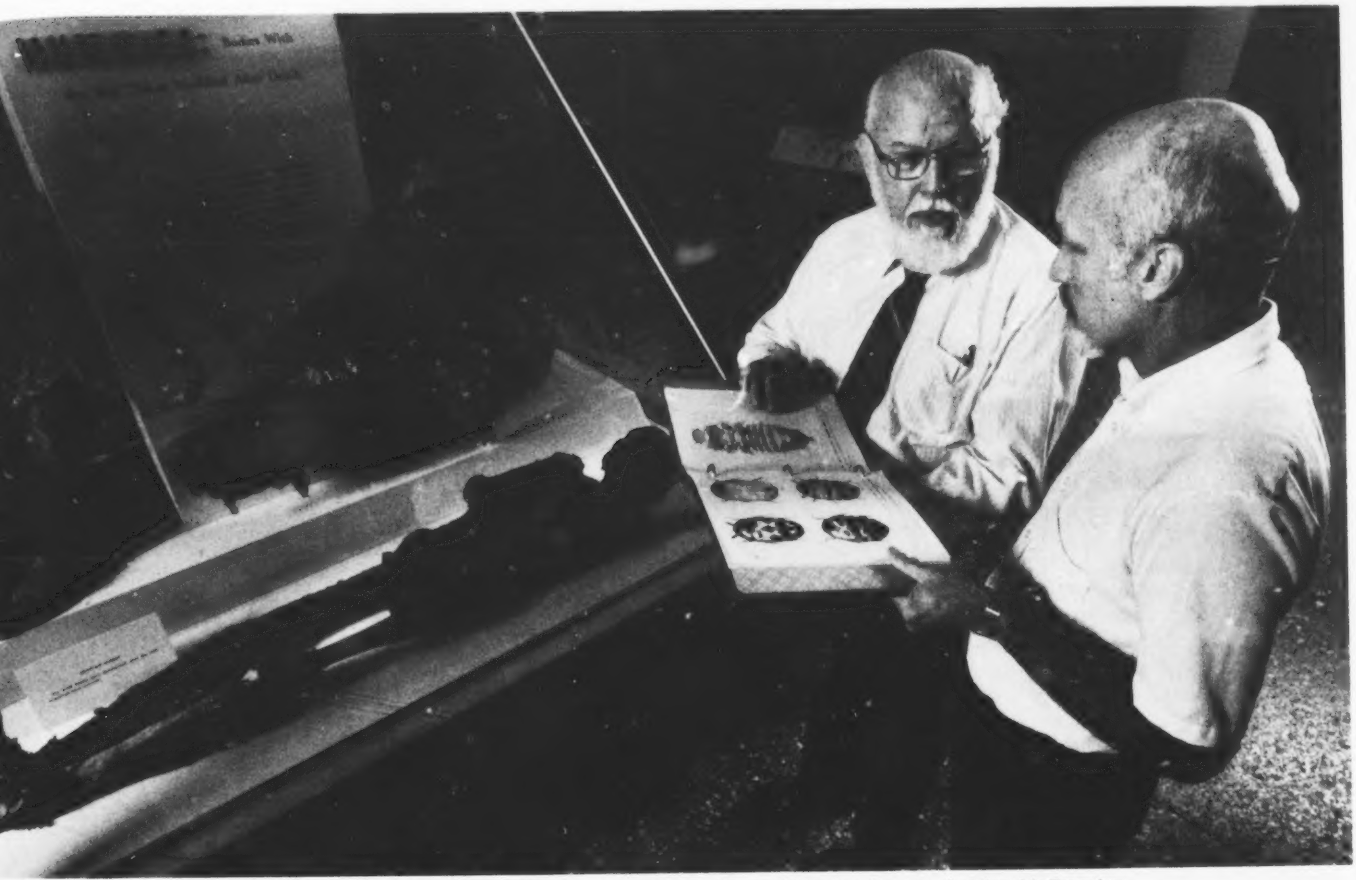
Kingsolver also scores high in *urgents,* particularly for the infamous khapra beetle—the most persistent pest of stored grain in the world. The khapra hails from the hot dry subcontinent of India, he says, but its larvae can adjust to extremes in climates by actually reversing their growth cycle. And because they have a penchant for squeezing into tiny crevices, they can come through a fumigation unscathed. The khapra has sneaked into this country several times this century and has been eradicated as often, he says, but it is a constant threat.

Despite this vigilance, 25 to 30 new insect species enter the United States each year, often with drug traffic or through other illegal channels. One or two of them will become major pests. To hold the number to a minimum, SEL scientists send reference collections of pest insects not known to occur in the United States—or PINKTO, for short—to federal and state inspection stations around the country. The collections include more than 70 species—each displayed in its full life cycle from egg to adult.

"For every insect alive, there are at least two or three insect species that feed on it," says Nickle, who recently tracked three species of mole crickets back to their native Argentina. The crickets, like many other alien pests, came to this country during the eighteenth and nineteenth centuries, entrapped in the ballast of sailing ships. When the crew dumped the dirt, sand, or gravel onto American shores, the insects found a suitable new home. And like most other imported pests, "the crickets arrived in this country without their complement of natural enemies," Nickle says. Knowing where to look for these enemies is the first but very important step in any biological control program, he emphasizes.

Marsh, a specialist in parasitic wasps, strongly concurs. He cites the gypsy moth problem to illustrate the need for good taxonomic groundwork. Since the early 1900's, nearly 50 species of natural enemies had been imported to control the pest with little success.

Marsh and others launched studies on parasitic wasps and flies whose females deposit their eggs in gypsy moth larvae, killing the caterpillars.



Entomologists John Kingsolver (left) and Don Whitehead discuss drawings of dermestid beetles discovered eating this Egyptian mummy and identified by Kingsolver. The mummy is now on display at the Smithsonian Institution's Museum of Natural History. (1285X1373-27)

The search turned up a number of promising parasites that have since been brought to this country and released. Whether or not they become successful weapons in the battle against the gypsy moths remains to be seen, says Marsh, "but it does show how even a limited taxonomic study can be very useful."

"Insects are so numerous, and we truly know very little about them," says entomologist Ronald W. Hodges. Add to that, he continues, the fact that each insect has several life stages—an egg, four to seven larval stages which can appear quite different from one another, a pupal stage, and finally, a male and female adult that often do not look alike—and one can begin to see the problem.

Hodges' interest is the moths whose caterpillars are the most insatiable crop pests. He specializes in a superfamily of moths that contains nine separate families. One of the families has 180 known species in North America, 131 of which Hodges has described himself. Among moths, he says, that family is no bigger than the gnat's eye. He is now tackling a family whose best known member is one of the cotton farmer's insect nemeses—the pink bollworm. Within the next 20 years, he expects to describe 1,000 new species in this family of moths alone. "That is more than all the species of North American birds combined," he notes.

Describing new species is only part of the task. Taxonomists must also work backwards over the 200 years the system for classifying insects has been in use and sort out duplications. Because of language barriers and slow communications, several entomologists have described the same "new" species unaware that it had already been named.

Discounting these aliases, about 1 million species of insects and mites have been described so far. Estimates of the total number of species range from 3 to 30 million. Scientists with the SEL and their counterparts around the world will be kept busy for centuries to come.—**Judy McBride,** Beltsville, MD.

Lloyd Knutson is at the USDA-ARS Biosystematics and Beneficial Insects Institute, Building 003, BARC-West, Beltsville, MD 20705. ■

An Oilseed Crop With Promise

Cuphea, a relatively unknown plant outside the scientific community, might someday provide valuable oils for manufacturing soaps, detergents, surfactants, and lubricants and may have medical, nutritional, and dietetic applications as well.

In 1960, Agricultural Research Service scientists at the Northern Regional Research Center, Peoria, IL, discovered that unique properties of oils found in its seed make cuphea a potentially valuable new crop for the United States. Cuphea seed contain large quantities of medium-chain fatty acids such as lauric acid, which is used in manufacturing soaps and detergents. Other medium-chain fatty acids in cuphea can be used for clinical treatment of rare human ailments associated with fat absorption.

Current supplies of these chemicals come from coconut and palm kernel oils, but cuphea seed may be a better source. For example, some cuphea seeds contain up to 42 percent oil, with lauric acid as high as 85 percent of the total. Coconut oil only contains around 45 to 50 percent lauric acid.

During the past few years, the United States has imported annually about 500,000 tons of these oils, costing about $250 million. Because of wide fluctuations in their supply and price to industry and consumers, ARS is now taking a closer look at cuphea.

Anson E. Thompson, ARS plant geneticist at Phoenix, AZ, heads a research project to develop cuphea as a new crop for this country.

"Currently, cuphea's major shortcomings are excessive seed shattering (seed is lost because it falls to the ground before or during harvesting); seed dormancy (some seed doesn't germinate for several years); uneven flower and seed development, which makes harvesting difficult; and sticky seed hairs that plug conventional harvesting equipment," says Thompson.

Geneticist Anson Thompson emasculates cuphea flowers before crossing with other cuphea species as part of his hybridization program. (0985X1007-21A)

Weeds may also be a problem because cuphea is slow growing in its seedling stage and must compete with faster growing weeds.

"With adequate, sustained research, we should be able to solve these problems just as scientists have done with other crops," says Thompson who works at the U.S. Water Conservation Laboratory.

Fortunately, cuphea possesses much genetic variability, which makes it easier for plant breeders to develop superior plants.

Of the 260 or so known cuphea species, some mature plants resemble an herb, others are grown as ornamental shrubs; some are self-pollinating, others are cross-pollinating; some are annuals while others are perennial; and some produce seed oil that has manufacturing potential, others produce oil having potential medical uses.

Thompson with cuphea collection in greenhouse. (0985X1006-22A)

Above, top: Chemist Robert Kleiman of the ARS Northern Regional Research Center, Peoria, IL, determines fatty acid composition of cuphea seed oil through gas chromatography. (1284X1835-12A)

C. PROCUMBENS
C. CARTHAGENENSIS

Above: Cuphea seeds of different species are selected for germination studies aimed at increasing seed size. Currently, seed size varies so much by species that it can take anywhere from 7,000 to more than 50,000 seeds to make an ounce. (0985X1007-1A)

Some cuphea plants produce only 2 or 3 seeds per flower, others produce more than 100; some seeds germinate readily, others remain dormant for years; some have very small flowers, others are large and showy; some have deep purple flowers, some have white flowers, and others range between these colors; some have extremely sticky and hairy stems, leaves, flowers, and fruits, others are practically hairless.

Thompson has assembled a collection of 44 of the more promising species from Mexico and Central and South America for testing at the Phoenix laboratory. The three or four species native to the United States do not appear to have high enough potential for study at this time.

Cuphea doesn't seem to be particularly susceptible to any major diseases or insects, and it appears that seed production of 1 ton per acre will be possible, Thompson says.

He is looking for the best ones suited as parents for breeding and germplasm development programs. A major effort is underway to recombine and release new sources of genetic variability. The basic research will benefit plant breeders who are developing cuphea for growing conditions in other parts of the country.

T. Austin Campbell, ARS agronomist at Beltsville, MD, is developing annual species for humid and temperate climates. His research concentrates on conventional breeding and high-technology techniques such as propagating plants from single cells or from anthers to improve cuphea.

Robert Kleiman, ARS chemist at the Northern Regional Research Center, is chemically analyzing and evaluating original cuphea plant material and varieties produced through the breeding programs.

A unique three-way, equally funded program for developing cuphea, involving ARS, Oregon State University Agricultural Experiment Station, and member companies of the Soap and Detergent Association, is also in progress. The program is concentrating on determining yield potential and crop adaptability at 11 locations in Oregon, Arizona, Iowa, Illinois, Indiana, Maryland, Georgia, and Puerto Rico.

Thompson and other ARS scientists are also cooperating closely with scientists at the University of Arizona, Tucson, and Purdue University in Indiana. These projects are a result of interest in having cuphea available as a crop for their region's farmers.

Although ARS continues to expand its research and development program in cuphea, it will be several years before farmers can buy seed to plant. "If we successfully develop high-yielding plants that produce seeds containing, say 40 percent oil with at least 60 percent lauric acid, we could conceivably have a crop bringing farmers $300 to $400 per acre," says Thompson, "and I stress 'conceivable' because we still have much research to conduct.". New uses for the fatty acids in cuphea seed may be developed, and economic conditions may change, making the crop more or less valuable.—**Dennis Senft,**
Albany, CA.

Anson E. Thompson is located at the U.S. Water Conservation Laboratory, 4331 E. Broadway Road, Phoenix, AZ 85040. ■

Electron Beam Puts a Shine on Leather

Frank Scholnick always keeps a stylish pair of new shoes and a smart leather briefcase at work.

He is not a fashion model. Scholnick is a chemist on a special hides and leather research team of ARS scientists at the Eastern Regional Research Center in Philadelphia.

Scholnick's shoes and briefcase are eye-catching first samples of an imaginative part of the team's research—radiation-curing of leather.

The research team has figured out how to apply brief zaps of ultraviolet light or electron beam radiation to put finishes on leather. The radiation is less powerful than x rays and poses no hazard to people wearing the cured leather, says Scholnick.

The new leather treatment can offer "all the fashionable looks" on everything from wallets to suitcases, says Scholnick, as he shows off his samples to laboratory visitors.

Radiation-cured leather has excellent physical properties. Scholnick's sample pair of shoes are of an even tone of light brown soft leather. The briefcase is made of a rich dark brown leather with a semigloss finish. The new finishes are more scuff resistant than finishes applied by other methods, he says.

The treatment ingrains chemicals into leather moving through radiation equipment on a conveyor belt. Before entering the conveyor, the leather is covered with a wet film containing chemicals composed of small molecules such as acrylics. The irradiation solidifies the mixture by linking the small molecules into polymer chains that fix to the leather as a tough coating.

Such radiation curing saves at least 60 percent of the energy cost of conventional leather finishing and could result in considerable savings in plant space and labor, says Scholnick.

Commercially available radiation equipment, normally used to bond plastic coatings onto metal cans and some vinyl and wood products, was adapted for this project. The equipment is safe to operate. Built-in shielding protects workers so they need not wear protective clothing.

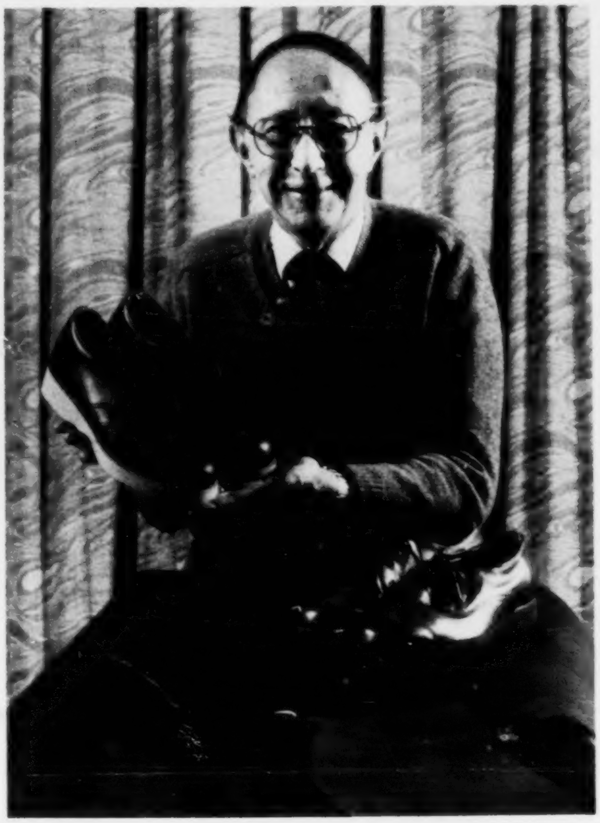
The hides and leather research team, formed and led for many years by the late Peter R. Buechler, an ARS chemist, is trying to wedge open a serious two-way squeeze on U.S. leather and tanning industries.

First, there is foreign competition. "Research helps return a competitive edge to U.S. leather industries. In recent years, we have sold most U.S. hides overseas and bought back leather products," says Scholnick. "This portion of the trade deficit is roughly $3.5 billion each year. Radiation curing can help U.S. manufacturers reduce the deficit by selling finished leather overseas."

Second, federal and state environmental agencies are toughening pollution regulations on the industries, he said. Radiation curing of leather is nonpolluting. For the first time, leather can be finished with no escape of solvent chemicals. Instead of evaporating, the chemicals become part of the coating.

Radiation curing has undergone initial testing in commercial tanneries at the A.C. Lawrence Leather Co. of Danvers, MA. Paul Finnegan, the firm's director of Environmental Affairs, said recently that the radiation-curing concept is "great for the industry, although it still needs some more refining for each type of leather and type of finish desired by consumers".—**Stephen Berberich,** Beltsville, MD.

Frank Scholnick is at the USDA-ARS Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. ■



Chemist Frank Scholnick with examples of radiation-cured leather products. (1285X1379-11)

Computer "Fingers" Grain Thieves

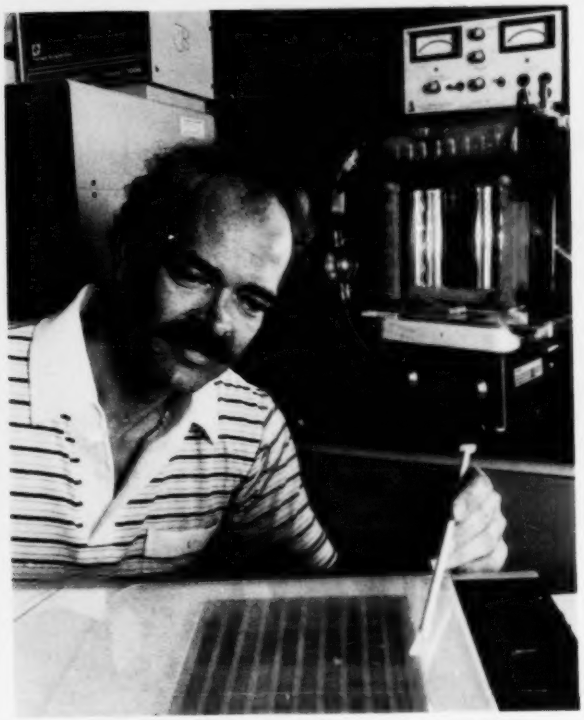
In June 1983, suspects in a grain theft were caught with five semitrailers of wheat near Atchison, KS. The wheat, worth more than $100,000, had been reported missing earlier from the Farmers Co-op Elevator of Atchison River Terminal.

Now it's relatively easy to identify thousand dollar bills when $100,000 is stolen from a bank. But grain has no distinguishing marks such as serial numbers or fingerprints. Or does it?

An expert witness was called to examine the samples. The witness was a computer using a new protein comparison technique that positively identified the grain in the trucks as being of the same variety as the grain in the Atchison River Terminal elevator.

George L. Lookhart, Agricultural Research Service chemist at the U.S. Grain Marketing Research Center, Manhattan, KS, presented in court the evidence obtained by the computer.

As Lookhart says, wheat varieties can be distinguished by a unique pattern, similar to a fingerprint, formed by separating either of two major proteins. The gliadin proteins were used to identify the wheat varieties in question. But the other major protein, the glutenin, can also aid in identification.



Chemist George Lookhart identifies wheat varieties by unique patterns formed when proteins are separated electrically into dark bands of varying intensity. (0985X1048-20)

The first step, a separation technique known as polyacrylamide gel electrophoresis (PAGE), is widely used in laboratories. It separates the gliadin proteins into bands based on their differences in molecular size and weight. Lookhart says, "After an electric current is passed through the gel and it is stained, it looks like gray Jell-O with dark bands that resemble rungs on a ladder."

Once the patterns are formed, Lookhart measures the distances and intensities of the bands and compares them with computer-stored data about the 88 most commonly grown U.S. wheat varieties.

He says this method is as accurate as using fingerprints to identify humans. "It's like having two people of the same sex, height, coloring, facial structure, body shape, and weight. How could you tell them apart based on their physical description? You would have to look further in their makeup for some distinguishing characteristic," says Lookhart.

However, the stakes are greater than just physical differences when identifying wheat flours for specific commercial purposes.

Identification problems became apparent when plant breeders began creating new varieties by crosses between wheat classes. Although PAGE cannot tell classes apart, it can identify a new variety regardless of its parentage once the protein patterns are established.

There is more at stake than simple identification. Wheat flours have different uses depending on their class. For example, hard wheat is used for breadmaking, soft wheat is used for cookies and crackers, and durum wheat is used for pastas.

Besides pointing the finger at grain thieves in the courtroom, the computer-aided PAGE method could be used by wheat breeders and USDA Plant Variety Protection officials who need to make positive identifications not easily done by visual examination.

"Speed is critical in this kind of work. And the computer coupled with PAGE doesn't let us down," says Lookhart. Although it takes about 6 hours to completely process one sample, it is possible to run as many as 80 during a day with the computer's help.

Co-developers of the computer-aided PAGE identification system were ARS researchers Berne L. Jones, Madison, WI, and Duane E. Walker, Manhattan, KS.—**Linda Cooke-Stinson,** Peoria, IL.

George L. Lookhart is located at the U.S. Grain Marketing Research Center, 1515 College Avenue, Manhattan, KS 66502 ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

PATENTS

Double-Dip Keeps Papayas Fly-Free

A hot-water bath treatment to kill fruit fly larvae and eggs in papayas has been refined and combined with an objective ripeness test.

The papayas get two baths (in either water or oil), one for 30 to 60 minutes at 38°C to 45°C and one for 5 to 30 minutes at 45°C to 55°C.

Before or after the baths, papayas that are ripe enough to have full-blown fly infestations are identified by using a colorimeter to measure the yellowness of the fruit. Papayas turn yellow as they ripen.

Ripe papayas have to be rejected because by then fruit fly larvae will have had enough time to reach the center of the fruit, which doesn't get enough heat from this treatment to kill the larvae.

The heat and times are carefully chosen to kill larvae and eggs near the surface without damaging the fruit.

The 1½-hour maximum time required gives this method an advantage over the most promising legal fumigant, which requires a minimum of 48 hours.

This is a joint invention of the Agricultural Research Service and the University of Hawaii. (See *Agricultural Research,* February 1985, p. 12.)

For technical information, contact H. Melvin Couey, USDA-ARS Pacific Basin Area, P.O. Box 4459, Hilo, HI 96720. *Patent Application Serial No. 757,396, "A Quarantine System for Papaya."* ■

A Better Way to Wrap Vegetables

Lettuce, cauliflower, cabbage—all can be wrapped mechanically in heat-sealable film.

This invention combines a conveyor belt with a sealing assembly. Unlike other machines, which feed film intermittently for objects of a particular size and shape, this machine feeds film continuously and can wrap irregular-shaped vegetables such as cauliflower.

This method eliminates the need for trays used in some methods to provide a uniform size and shape for wrapping. It also protects the loose outer leaves of lettuce and cabbage by packaging them in one smooth operation, eliminating damaging transfers.

For more information, contact Coordinator, National Patent Program, USDA-ARS, Rm. 401-B, Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. *Patent No. 4,516,385, "Wrapping Machine."* ■

Low-Salt Foods

See *Low-Salt Soy Sauce Tastes Just as Good,* page 5, for information on *Patent No. 4,503,082, "Method for Reducing Sodium Content and Simultaneously Increasing Potassium Content of a Food."* ■

How to Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

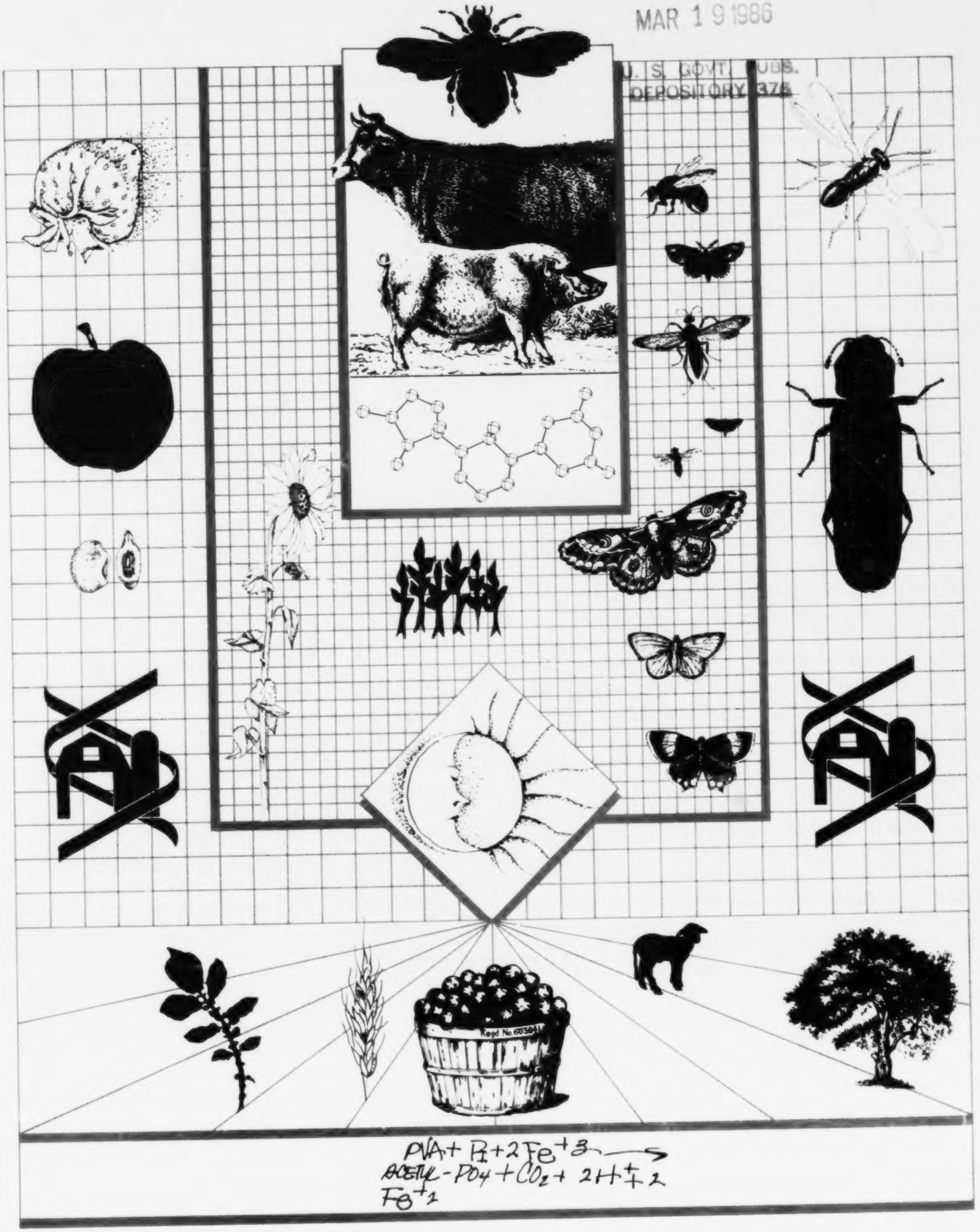
Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

34/3

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 3, March 1986

Agricultural Research

NEWARK PUBLIC LIBRARY
MAR 19 1986
U. S. GOVT. PUBS.
DEPOSITORY 378


Regd No 605941
PVA + Pi + 2Fe+3 →
ACETYL-PO4 + CO2 + 2H+ + 2
Fe+2

A 77.12:

Wanted: Developers for ARS Inventions

[The Agricultural Research Service makes many research discoveries that are patented by the U.S. Department of Agriculture. The following interview with M. Ann Whitehead, coordinator of the ARS National Patent Program, highlights recent progress in getting patents into use.—**Ed.**]

Ag. Res. Why does USDA patent its discoveries?

Whitehead. It's one way—the best way, as far as I'm concerned—of guarding against unfair, improper, or ineffective use of research which the public has paid for. By patenting research developments having a commercial potential, we can control their use through patent licensing agreements.

Ag. Res. ARS seems to be publicizing its patents more now than in previous years. Can you tell us why?

Whitehead. You are hearing more not only about ARS patents but all federal patents because of the Patent Law Amendments of 1980 and the Stevenson-Wydler Technology Act passed the same year. We're now starting to see results produced by these two pieces of legislation. The Patent Law Amendments give federal agencies the authority to award exclusive licenses on their patented technology, and the Stevenson-Wydler Act provides new ways to get inventions developed by federal agencies into the hands of private industry. Publicizing patents is vital to the whole concept of technology transfer, and exclusive licensing is making our patents far more attractive to business and industry.

Ag. Res. What do you mean by exclusive licensing and why is it so important to ARS?

Whitehead. Exclusive licensing means that the federal government can give one company or a limited number of companies the exclusive right to use research developed and patented by a federal agency. Without an exclusive right, there is little financial incentive for a company to invest heavily in one of our inventions.

Ag. Res. Why not?

Whitehead. Because once a company had refined and commercialized one of our inventions and then worked to establish viable markets for it, any other company could take the same ARS-based technology and compete in the same markets without having taken any of the risks. With exclusive licensing, companies that take the initiative and the risks won't have to worry about unfair competition from other companies that are simply waiting to see what happens.

Ag. Res. Doesn't this represent use of publicly funded research for the benefit of a select few?

Whitehead. Not at all. In fact, I would say the opposite is true. Without exclusive licensing, some of our research results might not get to the public—at least not in the form of a usable product or process—because of reluctance on the part of business to make the necessary investment. When an invention simply sits on the shelf, no one benefits. By protecting a business investment through exclusive licensing, we ultimately get the most for tax dollars that go into research. Also, a company must pay a royalty fee to the government for the exclusive use of one of our patents.

I should add here that we will continue to license selected patents on a nonexclusive basis—which means that they will be available to any company with the interest and capability of developing and marketing them. With each patent, we decide whether exclusive or nonexclusive licensing is the best way to get the technology used.

Ag. Res. How does the government determine whether to grant an exclusive license to industry?

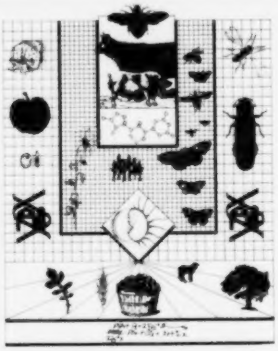
Whitehead. You have to remember that research results do not always translate into an immediately marketable product. The question of whether or not one of our patented research developments should be licensed on an exclusive basis hinges largely on the amount of capital investment necessary to turn the invention into a commercially viable product.

Before we grant an exclusive license, we must advertise our intent to do so and allow a 60-day period for public comment. And we must establish that granting such a license will not tend to lessen overall competition.

Ag. Res. Can you give us a example of an ARS invention that has been exclusively licensed?

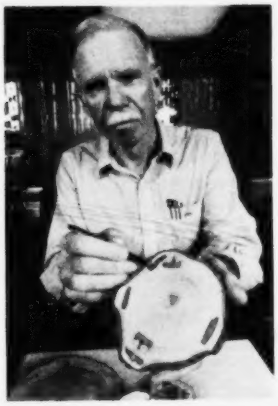
Whitehead. ARS recently developed a process for treating straw and other crop residues with hydrogen peroxide to make them wholly digestible by cattle. Applying the hydrogen peroxide process on a large scale, however, will require some additional technology and a lot of capital investment, and it was determined that exclusive licensing was necessary to make such a proposition worthwhile to private industry. Actually, we should call it a partially exclusive license in this case because three separate companies will have the right to commercially develop our process. [See story on page 7.]—Interview by **Steve Miller**, ARS, Beltsville, MD.

Agricultural Research



Cover art symbolizes the diversity of agricultural research.

p. 6



p. 10

p. 12

6 Designer Genes for Better Crops
New techniques solve major problems confronting scientists attempting to microinject plant cells with blocks of genes.

7 Crop Wastes Converted to Livestock Feed
Household bleach releases carbohydrates in corn stalks.

8 Snow Is Water in the Bank
Grow-your-own snow fences may be a key to more profitable farming.

9 Cataract Prevention May Be in Sight
Diet may be a key to preventing the nearly 400,000 new cases of cataracts occurring each year in the United States.

10 Trees Never Heal, They Just Seal
New test for young trees predicts how well they will resist decay when they are grown.

12 Female Fruit Flies Desire Loud Males
Robust singing styles of the larger males could make sterile-release programs more potent.

13 Microphones Monitor Plants' Water Needs
Lack of water may be signalled by tiny popping sounds too faint for the human ear.

DEPARTMENTS

4 AgNotes:
- Jetstream Hitchhikers
- Mysteries of Plant Roots Tapped
- Bollworms Find Okra-Leaf Cotton Less Tasty
- Exploring East for Landscape Plants

14 Technology:
- New Flower Seed Thresher Cuts Hand Labor
- Night Light Curbs Hydrilla Reproduction

16 Patents:
- Spinning Filament Seed Thresher
- Softer Permanent-Press, Flame-Retardant Clothes
- Cancer Inhibitor Found in Plant
- Fungicide Pellets With Live Fungi Inside

Vol. 34, No. 3
March 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

Jetstream Hitchhikers

Hitching rides on the jetstream takes some insects exactly where they want to go. The adult aster leafhopper, for example, travels this route from its winter hosts in the South to its summer food supply, including the barley fields of the North.

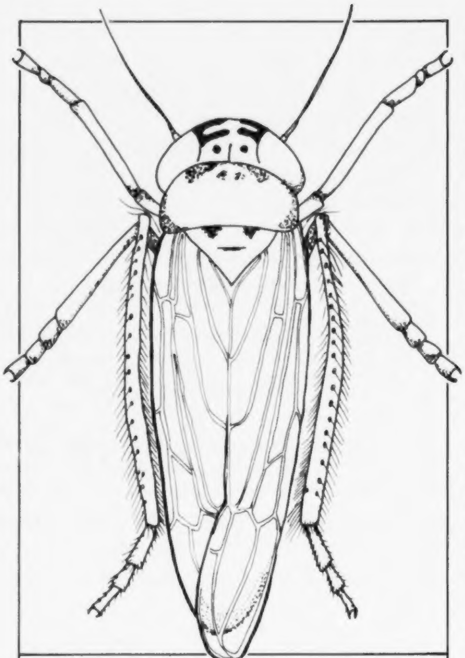
These migrants take off from Louisiana, Arkansas, and parts of Kansas and Missouri in mid-April when temperatures are 60°F or more. Blown north on the jet winds, they plague barley farmers with a virus that stunts the growth of emerging plants.

Damage varies with how early in the growing season the leafhopper lands and starts infesting new shoots. When arrival time coincides with new plant growth, usually in May, damage can be severe, and barley farmers can lose up to 25 percent of their grain crop.

Roland G. Timian, an Agricultural Research Service plant pathologist at Fargo, ND, found that about 15 percent of 800 adult leafhoppers *(Macrosteles fascifrons)* collected in May and June 1983 carried the oat blue dwarf virus. Because the virus has not been found in native plants and since it requires an incubation period of 2 to 3 weeks in the insect before the leafhopper can transmit the disease, Timian believes they acquire it from their winter oat or wheat hosts. He bases this conclusion on his discovery of the virus on winter oats in Arkansas.

Timian says planting barley earlier in the growing season will give the plants a better chance of escaping infection when they are most vulnerable to the severe stunting that results in yield losses.

In related research on migrating insects, William B. Showers, ARS research entomologist, Ankeny, IA, says that corn pests such as armyworms and cutworms also fly jet winds out of the south and can travel to northern states within a few days.—**Betty Solomon,** ARS, Peoria, IL.



Adult aster leafhopper. (PN-7198)

Roland G. Timian is with USDA-ARS Cereal Genetics and Pathology Research, Department of Plant Pathology, North Dakota State University, Fargo, ND 58105. ■

Mysteries of Plant Roots Tapped

Plant roots can tear apart granite boulders and upheave streets and sidewalks in their quest for water and nutrients. Like pry bars, roots penetrate minute cracks, then elongate and thicken to part some of the Earth's hardest materials.

Scientists have measured the pressures roots exert to penetrate soils—up to 150 pounds per square inch or five times the pressure in automobile tires.

"How roots penetrate soils to extract water and nutrients is not well understood," says Agricultural Research Service soil scientist Arnold Klute. He is now seeking additional information on roots to answer some of these questions.

First priority was inventing special research tools—including a miniature pressure gauge less than five millionths of an inch in diameter, to record pressures inside individual root cells, and sensitive rulers to measure root growth, often less than one thirty-second of an inch per hour.

Using this equipment, Klute and Colorado State University graduate student Douglas E. Emery were able to detect in growing root tips minute pressure changes caused by the plant's environment.

They discovered that plant roots will sometimes stop growing during the day. Other researchers have reported that roots stop growing in response to stresses such as lack of water, but Klute and Emery are the first to detect a daily cycle.

"The beauty of the micropressure probe is that we don't have to cut up the plants to use it. Previous studies necessitated actual root removal and destruction. We can check the root several times as it grows right in the soil," says Emery.

Greenhouse studies with pinto beans indicate that root growth is faster in daylight than in darkness but pauses when temperatures reach about 110°F with relative humidity about 30 percent.

The studies have been moved to a smaller, more accurately manipulated environment—a growth chamber—which will allow tests of several other variables, including carbon dioxide and relative humidity, that may affect root growth.

Klute says their research is basic but will yield information necessary to analyze a plant's ability to penetrate compacted or dry soils. "Eventually we want to predict how readily a root system will penetrate soil to find new water. This information would help plant breeders in their search for better plants."

Another benefit from the research will be the knowledge needed to improve computer programs that turn irrigation pumps on and off. These programs are often elaborate but contain only generalized information on root growth, says Klute.—**Dennis Senft,** Albany, CA.

Arnold Klute is in USDA-ARS Soil-Plant-Water Research, Agronomy Department, Plant Science Building, Colorado State University, Fort Collins, CO 80523. ■

Bollworms Find Okra-Leaf Cotton Less Tasty

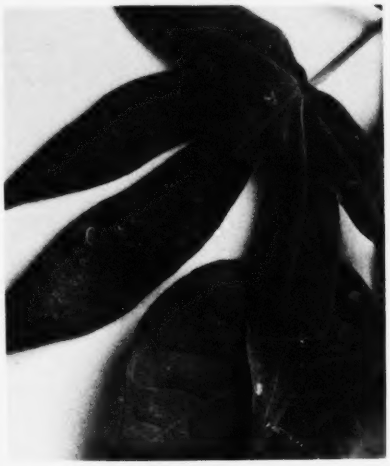
Cotton plants whose leaves have deeper than normal indentations between the lobes may have added protection against the destructive pink bollworm.

"Some cotton plants that have these okra-type leaves showed 30 percent less damage than commercially available, normal-leaf varieties," says Agricultural Research Service plant geneticist F. Douglas Wilson.

Okra-leaf cottons may contain specific chemicals or have tougher boll walls that discourage insect feeding, he says. In field tests near Phoenix, AZ, Wilson compared these cotton plants with normal-leaf varieties over two growing seasons for yield and seed damage. All were grown without insecticides so resistance to pests could be checked without interference from these chemicals.

One okra-leaf variety already commercially available yielded 7 percent more marketable cotton than a popular normal-leaf variety.

Wilson thinks it is possible to incorporate this insect resistance and yield advantage into other commercial varieties.



Okra-shaped cotton leaf has much deeper indentations between lobes than does the normal cotton leaf beneath it. (PN-7197)

Experimental okra-leaf versions of commercial varieties have been developed. Four out of eight in Wilson's study had significantly less seed damage caused by the pink bollworm than did the normal-leaf varieties.

However, none of the experimental versions available to Wilson yielded as much cotton as the normal-leaf parent varieties. More recently developed versions may be better, he says.—**Dennis Senft,** ARS, Albany, CA.

F. Douglas Wilson is at the USDA-ARS Western Cotton Research Laboratory, 4135 East Broadway Road, Phoenix, AZ 85040. ■

Exploring East for Landscape Plants

Explorers from the Agricultural Research Service's U.S. National Arboretum travel the globe in search of new ornamental crops.

Averaging one or two trips a year, they bring back new plants, seeds, and cuttings. Recently, they visited Japan and the Republic of Korea.

The Korea trip marks the second year in a 5-year program to explore its plantlife.

Barry Yinger, curator of Asian collections, and botanist Theodore Dudley collected seeds and cuttings from hollies, broadleaf evergreens, *Viburnum* species, and other trees and shrubs. These materials will be used for research and crossbreeding and, in some cases, as newly introduced landscape plants.

Korea was chosen because its climate is so similar to that of the eastern United States.

Also, scientists are anxious to collect samples of Korean species before urban development to accommodate a fast-growing population makes many of them extinct. Dudley says the islands off Korea's coast offer plants that do not exist anywhere else in the world.

Sylvester G. March, a horticulturist, spent a little more than a month in Japan collecting mainly dwarf flowering shrubs, flowering trees, and ground-cover plants. The specimens he collected were chosen from among those sold as garden plants in Japan but not in the United States.

He looked for specimens with the characteristics that help make a plant commercially successful—insect and disease resistance, hardiness, and beauty.

March says Japan was chosen for this collection "because it is an ancient culture whose people have been selecting plants for garden use for hundreds of years."

The Friends of the National Arboretum, Inc., a private nonprofit group, sponsored the trips to Japan and Korea, as they do most Arboretum exploration trips. Funds for sponsored trips come from private groups and individuals.—**Jessica Morrison,** formerly with ARS, Beltsville, MD.

Barry Yinger, Theodore Dudley, and Sylvester G. March are at the USDA-ARS National Arboretum, 3501 New York Ave., NE, Washington, DC 20002. ■

Designer Genes for Better Crops

By the 1990's, scientists may be routinely putting blocks of genes into plants so crops can better handle drought or salty soils.

Robert J. Griesbach, a plant geneticist with the Agricultural Research Service in Beltsville, MD, has developed a series of techniques that allow him to transfer blocks of genes from one plant cell to another and have the genes function. He injects the chromosome or part of a chromosome carrying the desired genes into a cell with a microscopic glass needle.

According to Griesbach, "plant characteristics, such as the ability to withstand high levels of salt or periods of drought, are almost always controlled by multiple genes—a block of 50 to 100 genes on a chromosome."

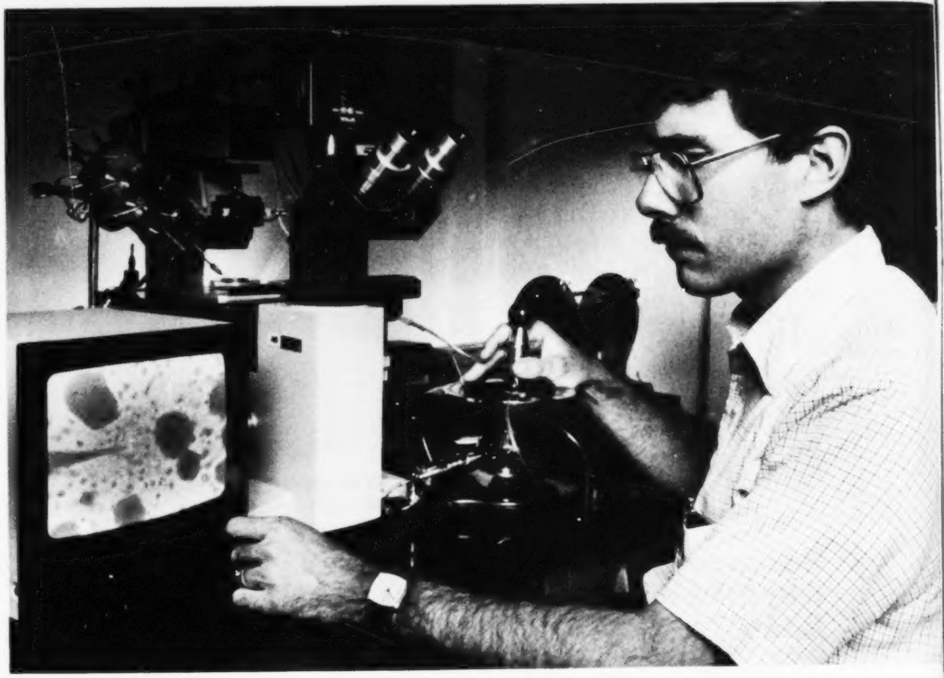
This is far too many genes to transfer using viruses or bacteria, he says. It would be like attaching 50 to 100 freight cars to a locomotive designed to pull 3.

Genetic engineering for plants is still in its infancy, Griesbach says. "But the possibilities are enormous, and developments will come quickly once they get underway." He says three other laboratories are now attempting to microinject genes into plant cells.

Scientists have been successfully injecting genes or chromosomes into animal cells since 1980, but plant cells have two major obstacles. First, a rigid cell wall has to be carefully peeled away with enzymes before chromosomes can be removed or injected. The peeled plant cell is called a protoplast.

Then, it is virtually impossible to inject chromosomes without puncturing the vacuole, which occupies about four-fifths of a plant cell.

Griesbach's techniques solve the major problems that have confronted scientists attempting to microinject plant cells. For example, he first removes the large central vacuole, which, among other things, traps and recycles the cells' toxic metabolites.



With help from a microscope attached to closed-circuit television, plant geneticist Robert Griesbach prepares to inject a chromosome into a petunia cell magnified 15,000 times. (0485X370-31)

While at Michigan State University, Griesbach and Kenneth C. Sink developed a technique for removing the vacuole without damaging the protoplast.

The technique relies on the principle that oil is lighter than water. The vacuole contains more oily chemicals while the remainder of the cell contains more water. By spinning the protoplasts in a centrifuge at 250,000 times the force of gravity, the vacuole rises to the top of the protoplast and eventually pinches off.

The protoplast will begin to regenerate a new vacuole in 24 hours, Griesbach explained, but that gives him enough time to inject chromosomes successfully.

At present, he said, "the lack of sophisticated tissue culture techniques for most varieties of agricultural crops is the major barrier to

Griesbach removes pollen from a drought-resistant petunia to cross with a new petunia (right), created through microinjection of chromosomes. Resulting seeds from the cross will be analyzed to determine if the inserted chromosomes contained genes for drought-tolerance. (1185X1234-27) wide application of genetic engineering technology to plants."

Griesbach is using his techniques to improve the petunia because it is one of the few plants that can be regenerated from a protoplast to a whole plant in tissue culture. But the techniques can be used to genetically engineer any plant, he said. He also noted that the petunia is the most popular ornamental bedding plant worldwide.

He is working towards inserting chromosomes that contain genes for drought tolerance but first has to determine which chromosomes carry these genes. Although gene maps are extensive for a number of animals, he said, not many plant genes have been mapped.

Griesbach works over a microscope attached to closed-circuit television. A video monitor projects a picture of the cell he is injecting at 15,000 times life size. He uses a tiny glass needle to enter the cell, then gives quick blasts of pressure from two nitrogen tanks to propel the chromosome into the cell's soupy contents.

For such a delicate operation, he says, "I don't rely on a steady hand; I use a micromanipulator to guide the needle into the cell."

About 25 percent of the wall-less petunia cells he has injected with a chromosome can be coaxed into growing roots and shoots in a culture medium. Griesbach says this is a good return for cells that have undergone such manhandling.

Scientists have also inserted chromosomes into plant cells by enclosing them in lipid envelopes and fusing the envelopes with protoplasts. Once inside, however, the lipid envelope has to be removed, Griesbach said, and that can be very tricky. The enzymes used to degrade the lipids can also destroy the chromosomes.—**Judy McBride,** Beltsville, MD.

Robert J. Griesbach is at the USDA-ARS Florist and Nursery Crops Laboratory, Bldg. 004, Room 108, BARC-West, Beltsville, MD. ■

Crop Wastes Converted to Livestock Feed

Lamb eats straw made digestible with hydrogen-peroxide, sweetened with molasses, and supplemented with corn and other ingredients. Biochemist J. Michael Gould and University of Illinois animal scientist George C. Fahey, Jr., look on. (0783X865-14)

Two companies have been licensed by the federal government to use a new chemical process developed by an Agricultural Research Service scientist for converting indigestible and often wasted crop residues into high-quality feed for cattle.

The process, in which crop residues are treated with a solution of hydrogen peroxide so that cattle can digest them, is being patented by USDA and licensed through the Department of Commerce's National Technical Information Service. It was invented by J. Michael Gould, a biochemist at the Northern Regional Research Center, Peoria, IL.

"The leaves and stems of crops like corn, wheat, oats, rice, and barley pack a lot of carbohydrate energy in the form of fibrous cellulose," says Gould. "Normally, the cellulose can't be efficiently digested by cattle. A plant substance called lignin glues cellulose fibers together and shields them from bacteria in the animal's digestive tract."

"But treating the residues with hydrogen peroxide dissolves the lignin so that the digestive bacteria can reach the fibers."

Gould says that hydrogen peroxide, a common antiseptic and bleach, can also be used on crop residues to facilitate the production of industrial-grade ethyl alcohol. (See *Agricultural Research,* July/Aug 1983, p. 12.)

M. Ann Whitehead, patent coordinator for ARS, says that rights to the commercial use of Gould's invention have been granted to Birks Agricultural Products, St. Paul, MN; and Interox America, Houston, TX.

She says that the companies will pay royalty to the government. A third company, Southwest Bio-Energy, Clovis, NM, will probably be licensed to use the process in the near future.—**Steve Miller,** ARS, Beltsville, MD.

J. Michael Gould is at the USDA-ARS Northern Regional Research Center, 1815 N. University, Peoria, IL 61604. ■

Snow is Water in the Bank

Tall wheatgrass barriers on a Montana farm trap snow to increase stored soil water. (MONT-10211)

Blowing, drifting snow may not seem like an asset in most places, but it could make annual cropping more profitable on 28 million acres of the northern Great Plains.

Current practice for many farmers in this area is to raise a grain crop only every other year so that soil moisture may accumulate during the years the land is fallow.

Five-foot-high natural snow fences of grass could make this practice unnecessary. Additional water from the melting snow, plus more efficient fertilizer use with the extra moisture, gave Agricultural Research Service scientists a nearly 50-percent increase in grain production. Wheat yields averaged 23.2 bushels per acre per year compared with 15.7 bushels under the alternate year, spring wheat and fallow system, says Alfred L. Black at Mandan, ND.

Under annual cropping with grass snow barriers, about 80 percent of the precipitation and soil water available was used by crops. With the spring wheat/fallow system, an average of only 45 percent of the total water available over a 2-year period was used.

"The fallow system is quite obviously a very inefficient water-storage method," he says. "The conventional spring wheat/fallow system consistently produced less grain per acre and less net income and used less of the available water than any other cropping sequence we studied."

Black, now head of the Northern Great Plains Research Laboratory, worked with ARS soil scientists J.K. Aase and the late Francis H. Siddoway on the project, which they began in 1968 at Sidney, MT.

Tall wheatgrass planted in two rows 36 inches apart, running north and south and spaced to leave a 48-foot cropping area between them, provided the snow barriers. The researchers compared annual cropping with two other systems—2 cropping years out of 3 (winter wheat, spring wheat, and fallow) and 1 cropping year out of 2 (spring wheat and fallow). They also compared nitrogen fertilization at 30 pounds per acre with no nitrogen.

With grass barriers and annual cropping, the soil stored 3.1 inches of water—48 percent of the precipitation—during the 9 months between harvest of one crop and the planting of the next.

With alternate year cropping and no snow barriers, the soil retained only 3.5 inches of water or less than 17 percent of the total precipitation between crops.

Black says, "During the fallow period, most of the precipitation is lost to evaporation, with smaller amounts lost as runoff and deep percolation below the root zone."

Nitrogen is necessary to efficiently use the additional water saved through snow management, Black says, even though water is the most limiting factor in annual cropping systems. This dictates that specific soil water conservation practices, such as fall weed control, snow trapping, and maintaining upright stubble, be used. Nitrogen becomes the second most limiting factor. In the Montana tests, nitrogen applications of 60 pounds per acre did not show significant yield increases over applications of 30 pounds per acre.

Although the fallow system provides a degree of production stability, it wastes water and provides little control of wind and water erosion, Black adds.—**Ray Pierce,** ARS, Peoria, IL.

Alfred L. Black is at the Northern Great Plains Research Laboratory, PO Box 459, Mandan, ND 58554. ■

Effect of Snow Barriers and Added Nitrogen Fertilizer

(Average grain production in pounds per acre over 18-year test period.)

	No nitrogen	***30# of nitrogen***
Annual cropping w/snow barriers	900	1,390
Spring wheat-winter wheat-fallow	860	1,200
Winter wheat-fallow	890	1,060
Spring wheat-fallow	720	940

Cataract Prevention May Be In Sight

New studies could make cataract surgery the treatment of last resort by the turn of the century, according to a biochemist at the U.S. Department of Agriculture's Human Nutrition Research Center on Aging at Tufts University in Boston.

Allen Taylor, director of the Center's laboratory for Nutrition and Cataract Research, says that people may be able to delay the progressive clouding of the eye's lens through diet or medication.

With funding from USDA's Agricultural Research Service, Taylor and colleagues are finding how and why cataracts form and what substances—such as vitamins and minerals—guard the lens from the damaging action of sunlight and oxygen.

Nearly 400,000 new cases of age-related cataracts occur in the United States each year.
—National Society To Prevent Blindness

"Our objective is to help the lens protect itself," says Taylor. "Preventive measures would dramatically reduce the medical costs for cataract surgery—currently the only effective treatment for cataracts—and enhance the quality of life for the elderly."

According to the Congressional Subcommittee on Health and Long-Term Care, Americans will spend a minimum of $3.5 billion this year to have clouded lenses surgically removed and replaced by artificial lenses.

In 1977, about 3.6 million Americans had some visual impairment due to age-related cataracts, according to a National Society To Prevent Blindness survey, and nearly 400,000 new cases occur each year.

Taylor expects that his research group could begin making dietary recommendations to extend the life of the lens within 5 years. Protective eyedrops containing vitamins or other antioxidants will take longer to reach the public because they have to be approved by the U.S. Food and Drug Administration, he says.

Lenses taken from animals with sufficient vitamin C are better able to withstand normal oxidation from light than those from deficient animals.

In tests using lens cells kept alive in a nutrient solution and homogenized whole lenses, experimental pathologist Joanne Blondin of the cataract research group recently showed that dietary vitamin C does concentrate in the eye lenses of guinea pigs.

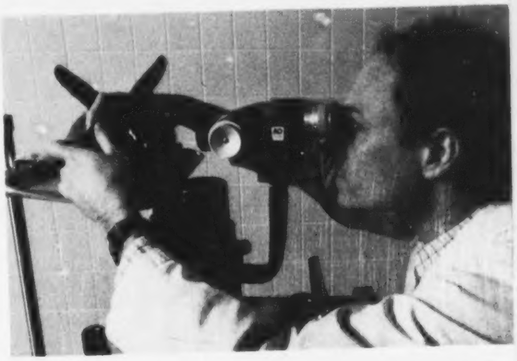
In more chemically oriented experiments, Blondin found that vitamin C can prevent sunlight and oxygen from oxidizing the lens' unique crystallins—proteins highly specialized to transmit light.

Other antioxidants, such as vitamin E and certain aspirin derivatives, will also protect the crystallin proteins, Taylor says. Studies are now underway to see if oral doses of vitamin E also move into the lens and have protective effects.

Lens cells are composed almost entirely of these proteins dissolved in water. The crystallins are arranged so they transmit light the way fiber optics do, Taylor explains.

When damaged, the crystallins clump together the way clouds form from droplets of water. Normally, the lens contains enzymes that break down the clumps and dispose of them. But the enzymes are proteins, too, Taylor says, and thus subject to damage the same as the crystallins. As people age, the enzymes are less and less able to clear away the damaged crystallins, which accumulate to form cataracts.

Cynthia Peltier, a graduate student with the research group, found that the minerals manganese and magnesium greatly enhanced the ability of certain enzymes to digest proteins and thus erase the clouds. However, this research is at an earlier stage than that for vitamins. Dietary recommendations for mineral levels will probably come later than for antioxidants, Taylor says.



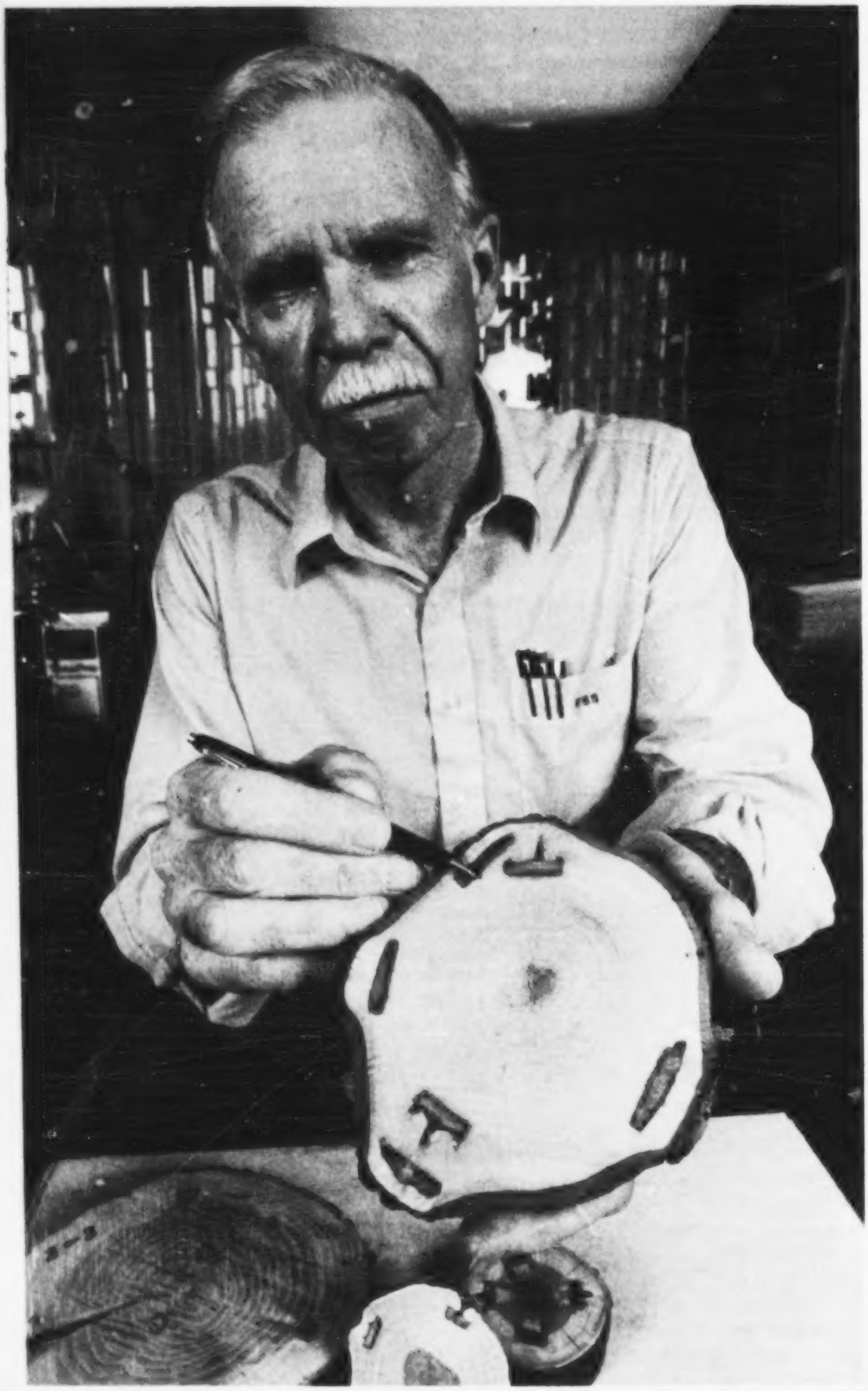
Top: "Slit-lamp" test is performed on a rabbit's eye by biochemist Allen Taylor to determine whether cataracts have occurred. (0186X041-12)

Above: Experimental pathologist Joanne Blondin examines rabbit eye lens' protein patterns to see whether protein damage has been delayed by vitamin C supplements. (0186X040-22)

As a future alternative to cataract surgery, Taylor proposes injecting clouded lenses with enzymes. "Through our research, we know which enzymes dispose of damaged crystallins and what substances turn the enzymes on or turn them off."—**Judy McBride**, ARS, Beltsville, MD.

Allen Taylor is at the USDA-ARS Human Nutrition Research Center on Aging, Tufts University, 711 Washington St., Boston, MA 02111. ■

Trees Never Heal, They Just Seal



Cross-section cut from a tree shows chisel wounds. Geneticist Frank Santamour points to rectangular areas that demonstrate the tree's ability to contain or wall-off damage. (0985X969-31A)

A whole new way of thinking about trees—sometimes called "a new tree biology"—has emerged from recent research done in U.S. Department of Agriculture laboratories.

"The new thinking could make trees on public streets healthier and safer," says Frank S. Santamour, Jr., a geneticist at the Agricultural Research Service's National Arboretum in Washington, DC.

Santamour and Alex L. Shigo,, formerly a plant pathologist with the U.S. Forest Service in Durham, NH, are key figures in the new tree biology. Their ideas are moving tree care away from traditional methods, many of which have been based on animal care practices.

"The difference is in how trees and animals respond to injury," Santamour says.

An animal heals by replacing damaged cells with new, healthy ones. A back yard tree "attacked" by a carelessly operated lawnmower, on the other hand, responds to injury by compartmentalizing, separating itself from the damaged area in two steps.

Trees are genetically programmed to varying degrees for the first step—surrounding wounds with a chemical barrier to limit the spread of decay-producing organisms. If done fast enough, decay cannot spread to healthy tissue.

The second compartmentalization step takes place in the wood grown after the injury. The cambium, or growth layer, forms a decay-resistant wall to protect new growth. The success of this step depends on the speed of the first one.

"We do know that there are individual trees within a species that can compartmentalize much more effectively than other trees within the same species," Shigo says.

The fact that trees with the best genetic capacity to compartmentalize don't decay to the point where they might break is a benefit for trees and for people or property near them, Shigo says. "These trees are the healthiest, toughest, and safest trees within a species."

Using a technique developed by Santamour, tree breeders can test a tree for walling-off ability before spending the time and money to propagate it.

A chisel is driven through the bark and into the wood of a tree in its second growing season. After one more season, the top part of the tree is cut off—just enough for a cross section of the wounded area but not so much that the tree can't grow new sprouts.

The age-old practices of cutting and grafting—which severely wound trees—have served as a sort of natural selection for the strongest "wallers."

If a brownish stain spreads in toward the center of the tree, decay has gone beyond the wound into new wood. This tree has clearly not walled off its wound. A grower could therefore eliminate it when checking for other desired characteristics, such as leaf color.

However, if there is a dark line completely surrounding the wound and accompanying decay, the tree has successfully contained the damage. This tree would be a top candidate for propagation.

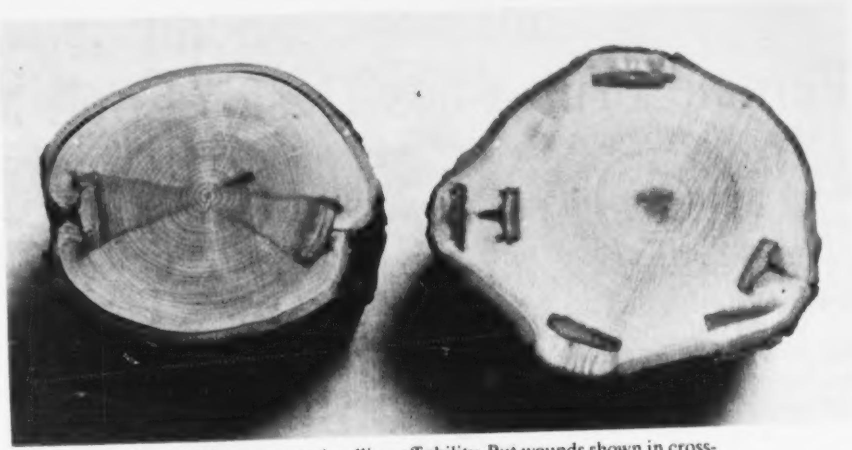
With Santamour's test helping to select the trees of the future, they could be safer, healthier, and longer lasting.

It appears that breeders and growers have inadvertently put some of the best specimens into the hands of consumers and onto city streets already, according to Santamour.

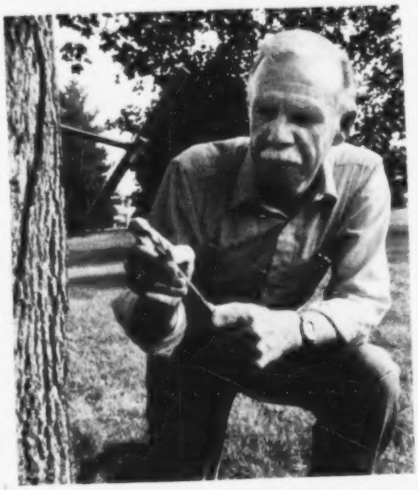
He tested 20 varieties of popular landscape trees—the Bradford pear, for example—and found that all of them walled off wounds and protected themselves from decay.

He says that the age-old practices of cutting and grafting—which severely wound trees—have served as a sort of natural selection for the strongest "wallers."

However, Santamour says, trees grown from cuttings or grafts make up only about 2 percent of the landscape trees on public streets. The other 98 percent consists of trees planted from seeds. How well these trees "wall" depends on their individual genes, and Santamour's test is really the only way to gauge that ability.



Tree cross-section on right shows good walling-off ability. But wounds shown in cross-section on left have not been walled-off, leaving the tree susceptible to micro-organisms that have spread decay to the heart of the tree. (0985X970-4)



At the U.S. National Arboretum, Santamour inspects a wood core extracted to look for discoloration caused by wounding. (0985X969-22)

Shigo says trees have been cared for improperly for many years. The misunderstanding has resulted because "concepts developed to explain animal biology are applied, almost unconsciously, to trees." In many ways, trees are treated like animals or human beings.

For example, people put dressings on their wounded trees. Shigo says that dressings have no value in helping a tree "get better" since the chemical barrier it puts around the wound is all that is really needed.

In addition, Shigo says, tree surgeons have traditionally dug out cavities of decay right into healthy wood—much like a dentist might drill a decayed tooth. But doing so only exposes healthy tissue to infection and decay.

The new tree biology is offering tree surgeons new ideas about tree pruning, too. Traditionally, surgeons have pruned trees by using a "flush cut." This cut, in which the surgeon puts the pruning saw right up against the trunk and then cuts straight down, damages the collar.

The collar, the swollen base of the branch, houses the secret to preventing decay after pruning—it supplies chemicals for walling off infection. Cuts into the collar literally open the tree up to invasion by insidious micro-organisms.

In fact, ARS researchers in Kearneysville, WV, have found that several very serious diseases of fruit trees stem directly from the flush cut, including *Cryptospora* canker in peach trees.

Improper cuts also turn trees into tempting treats for insects, Shigo says. "We can remedy a whole host of problems we have now by proper pruning."

To prune a branch, he says, a surgeon should cut it as close to the tree's collar as possible, without ever touching the collar itself.—**Jessica Morrison,** formerly with ARS, Beltsville, MD.

Frank S. Santamour, Jr., is at the USDA-ARS National Arboretum, 3501 New York Ave., NE, Washington, DC 20002. ■

Female Fruit Flies Desire Loud Males

Raising the volume of male fruit fly serenades could help lower the fruit fly population, proving that loud music isn't just for teenagers.

Females find the louder, faster buzzing of larger males more seductive and the males easier to locate.

Armed with data based on ultrasensitive sound recordings, entomologist John M. Sivinski, in Gainesville, FL, says that male flies raised for sterile-release programs should be larger and have more robust singing styles so that more females will zero in on them.

> ***"When a sexually attractive male fruit fly also happens to be sterile, that's it—there'll be no offspring, and the females probably won't mate again."***
>
> —John M. Sivinski, entomologist.

Sivinski has been investigating ways to more effectively use sterilized insects against the Caribbean fruit fly, which is similar in behavior to the Mediterranean fruit fly.

"The release of massive numbers of sterilized male insects into the wild can reduce an insect population by causing females to waste their reproductive capacity," explains Sivinski, "provided the females are attracted to the males."

"When a sexually attractive male fruit fly also happens to be sterile, that's it—there'll be no offspring, and the females probably won't mate again."

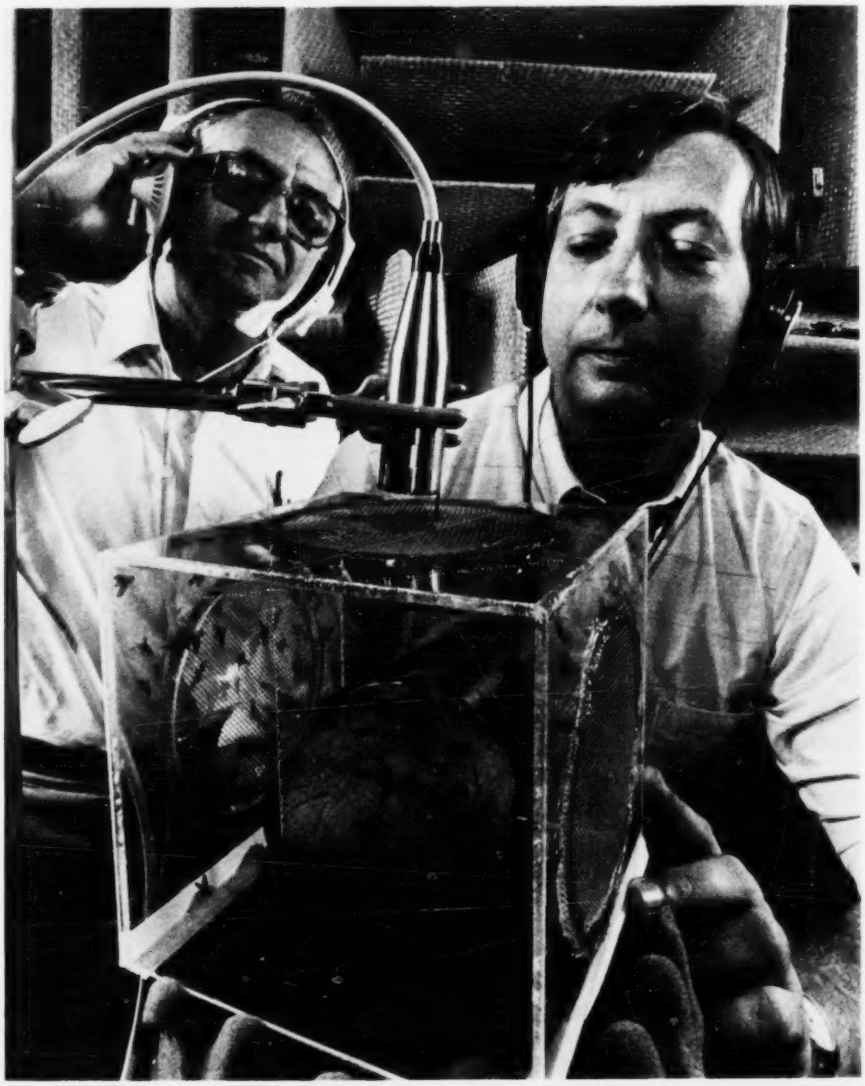
Sivinski's research depends on sound recordings made by J.C. Webb, an agricultural engineer who has built equipment that can detect minute sounds made by insects, including those of fruit fly larvae chewing inside a grapefruit. (See *Agricultural Research,* April 1985, pp. 13-15)

"The relationship of sound and behavior has become increasingly important to insect control," Webb says.

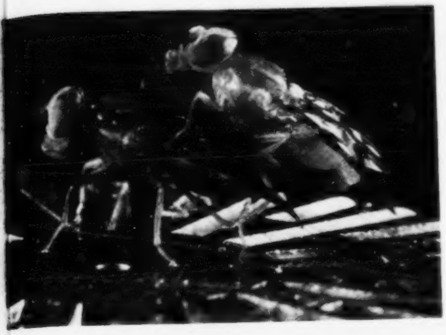
By recording insects inside a chamber equipped with microphones that could easily pick up the noise of a sharp knife slicing through soft butter, Webb has built an extensive library of courtship songs from the Caribbean fruit fly and numerous other insects.

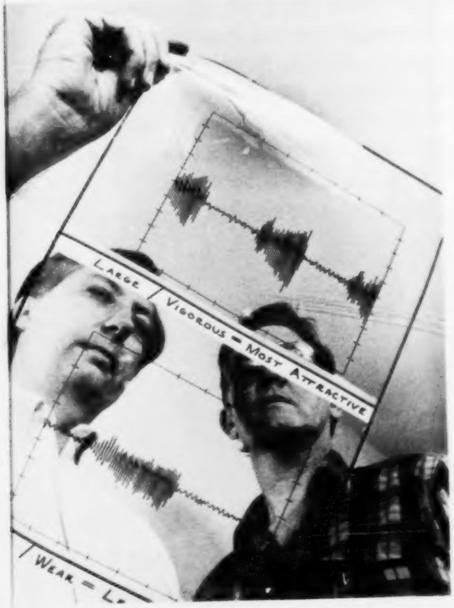
Male fruit flies produce intermittent buzzing sounds by beating their wings about 150 times per second. In a large male fruit fly, the buzzing comes at half-second intervals. In smaller males, the intervals are longer.

When male and female fruit flies finally get together and sexually couple, the intervals between buzzing vanish and the entire serenade acquires a higher frequency and greater volume.



In their soundproof studio in Gainesville, FL, entomologist John Sivinski (right) and agricultural engineer J.C. Webb record mating songs of captive Caribbean fruit flies. (1285X1334-15)





Top: Attractive to his mate because of his intense song, this sterile fruit fly will impart no progeny. (1285X1336-14)

Above: Sivinski and electronic engineer Carl Litzkow study wave forms or signatures of fruit fly songs. The signatures, distinctive by species, have been transcribed onto acetate from studio recordings through frequency analysis and digital plotting. (1285X1335-15)

"If the volume isn't sufficient," says Sivinski, "the female will literally throw off the male. And small males can't sing loud enough." —**Steve Miller,** Beltsville, MD.

John M. Sivinski is at the USDA-ARS Insect Attractants, Behavior, and Basic Biology Research Laboratory, Gainesville, FL 32604. ■

Microphones Monitor Plants' Water Needs

Like parents aroused from sleep by a crying child thirsty for water, farmers may someday listen for tiny popping sounds plants make when they need water.

Miniature microphones and supersensitive electronic measuring equipment now make it possible for scientists to record such sounds says Edwin L. Fiscus, an Agricultural Research Service plant physiologist at Fort Collins, CO.

During the past two summers, Fiscus monitored the high-frequency popping sounds given off by the xylem, or water tubes, in corn plants.

"The number of pops that the equipment detected appears to indicate how much water stress the corn is undergoing," he says. "This may give us an indication of when to irrigate rather than waiting for some other sign, such as wilting."

Fiscus explains that the popping sounds are made as the xylem carries water and nutrients from roots to leaves. When there is enough water in the soil, water moves upward through these tubes under tension. When soil is dried out or when plants need more water than is available, the tension in the tubes becomes too great and the water tube breaks, making a popping noise.

Air pockets form in the water tubes when they fracture. Some plants refill their tubes at night if there is enough water in the soil. These plants are then ready the next morning to continue growing. Plants that can't refill their water tubes wilt.

Some farmers, like many gardeners, apply water to their plants after they notice wilting. While the plants more often than not seem to recover from this stress, their growth and eventual yield may have been reduced. Other growers prevent this possibility, but waste water, by irrigating too often, Fiscus says.

The plant-acoustics research is part of an overall project to find an easy, reliable way to monitor water stress in crop plants. It is being carried out in cooperation with Melvin T. Tyree, a biophysicist at the University of Vermont in Burlington, who developed the equipment and supervised its installation and use during these experiments.

Plants are very noisy when they grow. Various parts, such as the corn leaves and the stalk, make noise when they slide against each other. The rustling of leaves in a breeze and the bending of the stalk are other sources of noise. Tyree says, "To hear the water tubes popping, we had to filter out everything else."

The miniature microphone operates at frequencies around 100 kilohertz or about five times the highest frequency detectable by humans. At this level, only the sounds created by the plant's breaking water tubes are recorded.

Stanley D. Wullschleger, a plant physiologist who worked with Fiscus, says their data will provide basic information on plant growth. Other scientists might use this information to find plant varieties that are better equipped to move water and nutrients from roots to leaves than other plants in the same species.

"This might lead to a new way to select superior plants for feed and food production as well as increase the efficiency of water use by irrigators," says Fiscus.—**Dennis Senft,** ARS, Albany, CA.

Edwin L. Fiscus is in USDA-ARS Soil-Plant-Water Research at the Crops Research Laboratory, Colorado State University, Fort Collins, CO 80523. ■

New Flower Seed Thresher Cuts Hand Labor

Beautiful flowers often have seeds armed with barbs, stickers, or hairs that protect the seeds but interfere with planting.

Flower seeds, such as marigold, gazania, arctotis, and anemone, which are grown primarily for the bedding plant and cut-flower industries, often have seed appendages that are very difficult to remove with conventional equipment.

Seed processors often have to remove these by hand. Otherwise, they tangle with other seeds and bits of debris and reduce the ability of precision mechanical planters to place single seeds in the soil at proper intervals and depths.

When seeds cannot be conditioned for machine planting, they must be planted and thinned by hand, thus raising production costs.

Enter on the scene a new, whirling-filament seed thresher that may solve this problem. Its nylon line knocks undesirable structures off a seed much like a string trimmer cuts weeds around a lawn.

"Seed threshers that use a rubbing action can't remove the more fuzzy, hairy appendages and tend to damage seeds," says agricultural engineer Arnold G. Berlage of USDA's Agricultural Research Service. "On the other hand, machines that use compressed air require a lot of energy and produce considerable dust."

The filament seed thresher was invented by Berlage and Douglas M. Bilsland, a research assistant in the Department of Agricultural Engineering at Oregon State University. It includes a chamber for seeds to be threshed, a system to draw air through the chamber to suspend seeds with appendages, and a rotating shaft of spools mounted in the chamber.

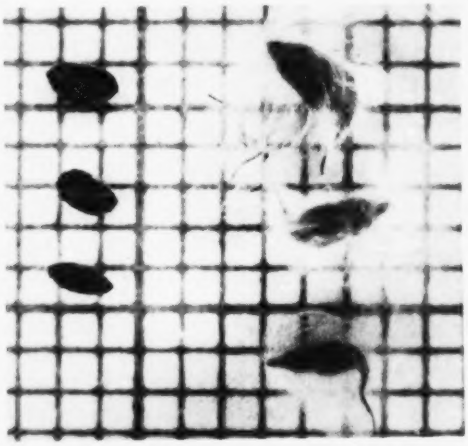
During operation, filament unrolling from the spools contacts the suspended seeds and removes the appendages. The appendage-free seeds drop to the bottom and are discharged from the container.

The filament seed thresher also provides a means of threshing seeds used for food, spice, oil, or other nonplanting uses. For example, the machine can remove the hull from certain oilseeds to obtain a husk-free seed, thereby increasing the oil percentage of the seed product.

"At present, we are experimenting with conditioning small volumes of high-dollar-value seeds," says Berlage. "But we think the machine can be scaled up to handle greater volumes."

A patent has been applied for, and individuals interested in manufacturing the machine or using the process can now apply for a license.—**Howard Sherman,** ARS, Albany, CA.

Technical information is available from Arnold G. Berlage at the National Forage Seed Production Research Center, Rm. 2074 Cordley Hall, Department of Botany, Oregon State University, Corvallis, OR 97331. ■



Anemone seeds before cleaning (right) are covered by down-like hairs. Anemone seeds on left were cleaned in the whirling-filament seed thresher. (0186X112-17A)

Left: Agricultural engineer Arnold Berlage (left) and Oregon State University research assistant Douglas Bilsland with a laboratory scale model of their new flower-seed thresher. (0186X112-10A)

Night Light Curbs Hydrilla Reproduction

By shining light on hydrilla at night, Agricultural Research Service researchers may have found the safest and cheapest method yet tried for controlling this extremely fast-growing aquatic weed.

In an experiment site on the Potomac River in Virginia, Lars W.J. Anderson of the Aquatic Weeds Control Laboratory, Davis, CA, was able to cut hydrilla reproduction by 50 percent, by using night lighting. The Potomac is one of many U.S. waterways that hydrilla—if uncontrolled—could easily clog.

"We hit hydrilla when it was vulnerable," Anderson said in describing his experiments of August-September 1985. "Our strategy was to shine overhead lights on these plants at a time when they need uninterrupted stretches of darkness to form reproductive parts." He estimates that a 75- to 95-percent drop in reproduction might be possible; he has already been able to reduce formation of reproductive buds by 95 percent in laboratory tests.

At a Potomac River marina in Alexandria, VA, plant physiologist Lars Anderson places strands of reproduction-foiling lights in heavy mats of hydrilla. Assisting Anderson are research associate Madeline Ames and aquatic ecologist Steven Spencer. (0885X866-29)

Marinas and other sites where electricity is readily available would be the most practical sites for the night-lighting approach.

"If we can use night lighting for several years in a row, to slow formation of reproductive buds, we may be able to get the weed under control," Anderson says. The best use of night lighting may be to combine it with other, more conventional techniques, such as mowing with mechanical harvesters, using divers to maneuver underwater vacuums to suction hydrilla from river bottoms, or applying herbicides.

Hydrilla reproduces from small, bulblike reproductive parts known as tubers and turions. The lengthening of nights during summer and fall triggers formation of the tubers in the soil and turions on the tips of shoots. In the fall, when the plant dies, the turions either fall off or break off the shoots; they drift with the current and eventually sink to the bottom. The tubers remain in the soil. In the spring, both the tubers and the turions sprout and form new plants.

"It's true that hydrilla can spread in other ways, such as from pieces clipped off by an outboard motor," Anderson says. "But the newly established plants will eventually need to form tubers or turions in order to survive the winter and reproduce. That's where night lighting comes in."

Hydrilla has been reported in more than a dozen states, from Florida to California. If uncontrolled, dense mats of the hardy plant can entangle swimmers or boaters, snag fishing lines, and interfere with irrigation and flood control. The weed can grow from 2 to 4 inches a day, forming strands 10 to 15 feet long.

The idea of using lighting to confuse plants and disrupt normal reproduction isn't new. It's a trick that's widely used to produce poinsettias, chrysanthemums, and other flowers at times of the year that these plants wouldn't normally be in bloom. The technique is based on what is known as photoperiodism, or the effects of day length on a plant's development.—**Marcia Wood,** ARS, Albany, CA.

Contact Lars W.J. Anderson at the Aquatic Weeds Control Laboratory, 222 Robbins Hall, University of California, Davis, CA 95616. ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

Spinning Filament Seed Thresher

See "New Flower Seed Thresher Cuts Hand Labor," p. 14, for information on *Patent Application Serial No. 779,958, "Filament Seed Thresher."* ■

Softer Permanent-Press, Flame-Retardant Clothes

This new treatment gives cotton-polyester and other blend fabrics a finish that is both permanent-press and flame-retardant.

The old method tends to make fabrics stiff because of chemicals added to the finish to trap the treatment compounds on the fabric's surface. The new method relies instead on reactive compounds which chemically bind the treatment compounds deep inside the fabric.

For technical information, contact Robert J. Harper, Jr., USDA-ARS Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179. *Patent Application Serial No. 749,905, "Process to Impart Smooth-Dry and Flame-Retardant Properties to Synthetic-Cellulosic Blended Fabrics."* ■

Cancer Inhibitor Found in Plant

Scientists have found rare anticancer compounds in a plant not a member of the only two plant families previously known to have the compounds. What's more, the compounds found this time have a slightly different chemical structure than other reported ansa macrolide compounds.

Laboratory tests have shown the unique compounds found in *Trewia nudiflora*, a tree native to tropical areas of India, are effective against cultivated cells of human epidermoid carcinoma of the mouth and two types of cancer in mice.

For technical information, contact Richard G. Powell, USDA-ARS Northern Regional Research Center, 1815 N. University Street, Peoria, IL 61604. *Patent No. 4,313,946, "Chemotherapeutically Active Maytansinoids from 'Trewia Nudiflora'."* ■

Fungicide Pellets with Live Fungi Inside

Now there's a way to put living fungi in a gel pellet to kill harmful soilborne fungi.

The fungi, together with wheat bran for food, are added to a sodium alginate solution. All the ingredients are blended and then added to a calcium salt solution, drop by drop. Each drop forms a gel bead which dries into a pellet.

The pellets tested produced living colonies of fungi when applied to farmland. The fungi effectively controlled *Rhizoctonia solani*, preventing damping-off disease of cotton and sugar beet seedlings.

For technical information, contact Jack Lewis, USDA-ARS Soilborne Diseases Laboratory, Bldg. 011A, BARC-West, Beltsville, MD 20705. *Patent Serial No. 749,906, "Preparation of Pellets Containing Fungi and Nutrient for Control of Soilborne Plant Pathogens."* ■

How to Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

34/4

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 4, April 1986

Agricultural Research

What a Way to Grow!
Story on page 6

NEWARK PUBLIC LIBRARY
APR 1 8 1986
S. GOVT. PUBS.
EPOSITORY 376

A 77.12:

Genesis From a Single Cell

Growing plants from a single cell or from tiny bits of plant tissue is a sometimes difficult but almost always rewarding enterprise. This issue of *Agricultural Research* features an article about the advances that tissue culture—as this technique is called—has made both in commercial propagation of plants and in basic scientific research.

Despite increasing knowledge in the field, tissue culturists often say that regenerating plants from cellular tissue nurtured in test tubes and petri dishes is still more of an art than a science.

True or not, tissue culture is a major part of biotechnological research and is a specific subject of scientific inquiry as well as a laboratory technique. Ultimately, it can be seen as bringing together two components of biological research that are critical to the development of better crops: genomic analysis and the study of tissue differentiation.

Genomic analysis deals with the chemical (DNA) structure of chromosomes, which are the tightly coiled strands of genes in the nucleus of a cell. The study of tissue differentiation, on the other hand, asks how these genes are able to coordinate the multiplication of cells into different tissues, organs, and functions that give rise to whole plants. Naturally, these two specialties are closely related, and that relationship is examined through the science of tissue culture.

Tissue culture is based on a 19th century concept of totipotency, which holds that each cell within an organism contains all of the genetic information necessary for creating a new organism. As it applies to plants, the concept has been proven correct. A single plant cell, whether it be taken from a leaf or stem or flower or root, can grow into a whole new plant, provided the cell is properly nurtured in a solution of salts, sugars, vitamins, and hormones.

There is at least one advantage to propagating plants through tissue culture: once a plant with the desired characteristics is found or developed, massive numbers of identical and genetically uniform plants can be produced immediately. As the article on page 6 points out, many horticultural crops are being mass-produced in new industries based on tissue-culture methods.

But attempts at growing many major crops from cells have so far resulted in genetic deviations rather than genetic uniformity. Specifically, there has been an unpredictable loss of hereditary traits in the regenerated plants. Known as somaclonal variation, which means the changes occur without a sexual mix of chromosomes, this seeming contradiction to genetic logic has inspired new research into the use of tissue-culture technology. It may well prove to be a way to induce mutations that can be tracked from their inception at the molecular level.

Once a mutation is established, it can serve as a "marker" for studies on the genetic control of tissue differentiation. By learning how mutations of DNA are expressed during plant growth in tissue culture, researchers can acquire the knowledge necessary to make alterations of the genetic code more systematic and the outcomes more predictable. Similarly, the technology of tissue culture will also be refined to make it a reliable method for the genetically stable propagation of our major crops.

Such declarations may sound premature. There is no guarantee that one research development will lead to another, or that we will acquire the necessary knowledge every step of the way. But a strong program of systematic experimentation in tissue culture will increase the likelihood of success.

Jerome P. Miksche, National Program Leader for the Agricultural Research Service in plant physiology and biotechnology, says the key to such a program will be the development of model tissue-culture systems that can be physically, chemically, and biologically regulated to yield results that are predictable and reproducible. The models must establish complete control of all tissue-culture conditions and be able to relate those conditions to changes in DNA. Only then, he says, can we begin to truly understand the processes of somaclonal variation and tissue differentiation in plant growth.

Miksche believes that a concerted effort in the development of model tissue-culture systems will enable us to achieve, over the next 10 to 15 years, a high degree of genetic stability in all crops propagated through tissue-culture techniques. Without such an approach, he says, the timetable could be as long as 50 years. If so, the decades that are saved could mean a lot to agriculture by the turn of the century.—**Steve Miller,** ARS.

Agricultural Research

This strawberry plantlet is but one example of numerous horticultural crops being lab-cloned commercially through a technique called tissue culture. Story on page 6. (0386X429-25A)

David F. Spencer was incorrectly identified in a photograph on page 15 of the March 1986 issue.

p. 8

p. 12

p. 13

6 Assembly Line Plants Take Root

Disease-free and extra vigorous, these plants bypass normal propagation in going from laboratory to farm.

12 Elderly Cautioned on Overuse of Antibiotics, Antacids

Normal uptake of B vitamins is blocked by changes in the digestive system.

13 Natural Neem Kills Cockroaches and Greenhouse Pests

Extracts from seeds and leaves could control over 80 major insect pects.

DEPARTMENTS

4 Agnotes:

Waxy Leaves Are Healthy Leaves
Eggs of Cotton Pest Devoured
Greenbugs Fooled and Leashed
Rare Bacterium Helps Cattle Digest Toxic Plant

15 Technology:

Embryo Rescue Saves New Gene Combinations
Lettuce, Melons, Grapes Travel Cooler

16 Patents:

A Better Way To Shake Trees
Natural Preservatives
Permanent-Press Fabrics That Can Be Dyed

Vol. 34, No. 4
April 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Waxy Leaves Are Healthy Leaves

Homemakers may not like it on their floors, but waxy buildup could be healthy for plants and animals.

Research has shown that natural wax on the surface of plant leaves slows the loss of moisture from a plant. More recently, scientists have learned this waxy coating acts as a barrier to insect attacks.

Agricultural Research Service scientists in Logan, UT, and Manhattan, KS, are breeding new waxy-leaf alfalfas to take advantage of these characteristics.

In addition, "wax may reduce the risk of bloat in cattle that graze on highly nutritious alfalfa plants," says plant geneticist Melvin D. Rumbaugh at Logan.

Bloat is a frequently fatal accumulation of gas bubbles in an animal's stomach. Cattle are the most likely to bloat, but sheep and other ruminants can be affected. Research with plants other than alfalfa indicates that wax on plants helps break down the foam, allowing the gas to escape, and that the more wax, the less bloat.

Rumbaugh estimates losses due to bloat reach $300 million a year. "It's even more," he says, "when you account for milk and weight losses that result when farmers try to reduce bloat by feeding their livestock less alfalfa."

Rumbaugh and colleagues at Logan found that the natural wax on 28 common types of alfalfa varies considerably—from 138 to 460 milligrams per square meter of leaf surface.

Rumbaugh has developed both high-wax and low-wax alfalfas by crossing these U.S. varieties. They will be compared during the 1986 growing season for their ability to withstand drought and insect attacks.

Agronomist Edgar L. Sorensen, in cooperation with the Kansas Agricultural Experiment Station at Manhattan, is taking a different route for waxy leaves. He crossed a wild, low-growing waxy species from northern Italy with a widely used U.S. species. The Italian alfalfa, *Medicago prostrata*, typically grows only inches long and flourishes in arid areas.

Wax production of this hybrid varies with the amount of water available to the plant. On plants grown on dryland, wax production increased and many strumae—balls of wax— developed on the leaf surface. None developed on irrigated plants.

Says Sorensen, "These drought-resistant characteristics can be bred into commercial alfalfa varieties, making it possible to grow alfalfa in dry areas where presently available varieties cannot survive."—By **Linda Cooke-Stinson** and **Howard Sherman,** ARS.

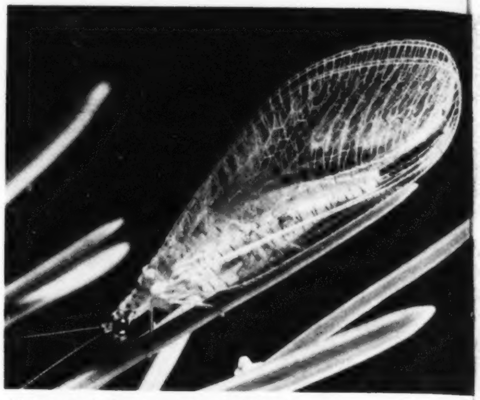
Melvin D. Rumbaugh is at the USDA-ARS Forage and Range Research Unit, Utah State University, Logan, UT 84322. Edgar L. Sorenson is in USDA-ARS Plant Science Research, Department of Agronomy, Throckmorton Hall, Kansas State University, Manhattan, KS 66506. ■

Eggs of Cotton Pest Devoured

Voracious insects that thrive naturally in the southwestern United States can devour up to 98 percent of eggs laid by the pink bollworms in cottonfields.

"At least three insects—green lacewings, lady bird beetles, and collops beetles—might be reared and released to protect cotton crops early in the season," says Thomas J. Henneberry, an Agricultural Research Service entomologist at Phoenix, AZ.

The highly destructive pink bollworm causes annual losses estimated at 25 percent of the crop value in the southwestern U.S. cotton-growing area.



Although delicate and beautiful as an adult, in its larval stage the green lacewing *(Chrysopa carnea)* can be a voracious predator of the pink bollworm. (Photo by Grant Heilman Photography)

"Most predatory insects seem to have insatiable appetites. Unfortunately, they are in constant battle to survive and often eat each other before attacking the pink bollworm," says Henneberry.

"Our goal is to find the one or two hungriest predators that would feast on pink bollworm eggs before eating each other. Then we could develop methods to expand their populations in cotton-growing areas," says Henneberry.

Henneberry doesn't believe his research will lead to complete elimination of insecticides. However, he does believe natural predators might be manipulated or conserved to provide control early in the growing season so fewer chemical applications will be needed later to reduce damage.

"If we can eliminate even one insecticide application, we reduce potential risk to the environment and make cotton production more efficient," says Henneberry.

He says none of the beneficial insects he has studied damage any commercial crops—only other insects.

Pink bollworms are most susceptible to predators early in the cotton-growing season. It is during this time that young plants provide few hiding places for their eggs.

Subsequent pink bollworm generations—there can be up to 5 generations in one 9- to 10-month growing season—lay eggs on cotton plant parts that are more inaccessible to predators.—By **Dennis Senft,** ARS.

Thomas J. Henneberry is at USDA-ARS Western Cotton Research Laboratory, 4135 East Broadway, Phoenix, AZ 85040. ■

Greenbugs Fooled and Leashed

How do you thwart a greenbug that can fly hundreds of miles and loves to feed on growing wheat, grain sorghum, and a host of other crops? One way, according to Agricultural Research Service entomologist Robert L. Burton, is to turn its genetic guidance system against it.

It seems that when greenbugs—really aphids—decide to migrate, they fly toward open sky. After a while their instinct reverses and they fly toward darker areas—bare soil, green crops, etc.

Gardeners have known for years that aluminum foil between vegetable rows cuts aphid infestations to a fraction. Aluminium foil isn't practical for wheat fields in the Great Plains, of course, but new research at Stillwater, OK, shows that straw, stalks, and leaves from a previous crop left on the soil surface work the same way. "Plowing under crop residues after harvest is a mistake when it comes to greenbugs," Burton says.

Another way to avoid the greenbug menace is to find varieties of wheat better able to withstand greenbug attacks. With this in mind, Oklahoma State University agronomist Jim Ryan, in cooperation with ARS entomologist James A. Webster, has taken to attaching a "leash" to the pests.

Obviously, it takes a mighty small "leash" for a pest not much larger than the period at the end of this sentence. The researchers actually glue a fine gold wire—finer than a spider's silk—to the backs of greenbugs.

With the aid of a magnifying glass, a tiny drop of silver glue is suspended on the end of a thread. A greenbug is gently touched to the glue drop, leaving a small spot on its back. The end of the gold wire is placed in the drop and the insect is then properly leashed.

The opposite end of the gold wire is soldered to a copper wire, which is buried in moist soil containing the wheat plant on which the harnessed insect is sitting. The result—a complete electrical circuit whenever the insect takes a "bite."

Ryan explains that very low voltages of electric current pass through the insect and plant with no harm to either. But with the use of an amplifier, these voltages are brought back to measurable levels and recorded.

The real goal is not to take the insects out for exercise, Ryan says, but to learn more about their feeding behavior and why and how some wheat plants resist them.

The researchers say that at least two of the wheat lines being studied show some tolerance to greenbug feeding.—By **Lloyd McLaughlin,** ARS and **Fred Causley,** Oklahoma State University.

Robert L. Burton is in USDA-ARS Plant Science Research, P.O. Box 1029, Stillwater, OK 74076. ■

Rare Bacterium Helps Cattle Digest Toxic Plant

Popular folklore has it that goats will eat nearly anything. So it may not seem surprising that goats in Hawaii have been eating *Leucaena*—a sometimes poisonous plant—and getting away with it.

Leucaena grows as a small, bushy tree. It is often praised for its drought resistance and its nutritional qualities as livestock feed.

Because the plant could become a valuable forage crop if other animals were immune to its toxic compounds, Agricultural Research Service scientists are studying how the goat survives its effects.

The goat gets its resistance from a special bacterium in its stomach that protects it from toxic substances in the plant, says Milton J. Allison, a microbiologist at the agency's Animal Disease Center, Ames, IA.

Tests of cattle in Texas and Iowa indicate they don't have the same natural protection. Allison and biological technician Herbert M. Cook at Ames compared stomach fluids in goats and cattle in the two states and found that cattle lack the protective bacteria that goats have.

But the bacteria can be transplanted from one animal to the other, as demonstrated in studies by Raymond J. Jones, of the Australian Commonwealth Scientific and Industrial Research Organization.

In Australia, steers with *Leucaena* poisoning symptoms—loss of hair, goiter, and ulcers of the esophagus—soon recovered after being fed mixtures of bacteria from food digesting in the stomachs of Hawaiian goats. In fact, other animals in the test herd recovered without the treatment, indicating that the beneficial bacteria were transmitted from animal to animal.

The plant's toxicity comes from a compound called 3-hydroxy-4(1H)-pyridone (DHP) that is produced by enzymes in both *Leucaena* leaves and rumen contents from an amino acid called mimosine. A pure culture of a bacterium that degrades DHP has recently been isolated by Allison and Cook from the mixed bacteria found in the goats. This, as yet, unidentified bacterium appears to be different from any previously described species.

Milton J. Allison is at the USDA-ARS National Animal Disease Center, P.O. Box 70, Ames, IA 50010. ■

Assembly Line Plants Take Root

Biologist Peter Carlson, of Crop Genetics International, checks growth characteristics of disease-free sugarcane plants. (0286X282-18)

Five years after Peter S. Carlson helped start Crop Genetics International, a small high-tech company in Dorsey, MD, he is ready for sales—of laboratory-cloned sugarcane and apple trees. As far as he knows, his company is the first in this country to sell tissue-cultured sugarcane and apple tree varieties.

"Plant tissue culture" is a term for a variety of techniques used to grow or genetically modify, preserve, or study plants and plant parts in laboratories, from tissue or even a single cell.

"Tissue-culture propagation is more an art than a science for commercial growers," says Carlson, a pioneer in tissue-culture research who has spent the past 5 years mastering its practical use. For the purposes of his company he needs to transform tissue culture from a science to an easy-to-learn production skill.

Carlson began with a few sugarcane plants raised in disease-free, quarantine conditions at USDA's Agricultural Research Service facility in Beltsville, MD, about 15 miles southwest of Crop Genetics. A. Graves Gillaspie, a plant pathologist with the ARS Microbiology and Plant Pathology Laboratory at Beltsville, provided the first few plants, at the request of Crop Genetics. ARS offers this type of service to any private or public firm that asks, in an effort to put publicly funded research to the widest possible use.

From a Few to Many

"Plantlet" is a word used by horticulturists to describe tiny plants that develop from their parents vegetatively, without seed.

But, Carlson's plantlets give a new twist to that definition—they come from pencil-sized tissue taken from near the tops of sugarcane stalks. He sterilizes the tissue surface and then puts these small stalks in a gelled solution (medium) in a petri dish. The medium causes the original tissue to sprout sugarcane plantlets. And more and more and more.

In 3 months, Carlson can get many hundreds of plants from one piece of stalk.

As the tissue multiplies, lab technicians, called culturists, must separate the plants into more containers and change the solutions. When the plant is ready to root, it's put in a larger container with the medium altered to cause rooting instead of sprouting. Once it's rooted, the plantlet goes into the greenhouse where it's planted in potting soil in Styrofoam trays.

If these were apple trees, they'd be ready for sale to an orchard. But sugarcane farmers don't plant sugarcane seedlings or even plantlets. They use either whole sugarcane stalks or stalk pieces (seed pieces) in furrows, growing plants from the buds on the stalks. In this sense, a sugarcane stalk is a lot like a potato: Both are stems with a large number of buds, the potato being an underground stem or tuber.

To get these seed pieces from sugarcane, Carlson ships his plantlets to company farms in Florida and Louisiana, close to sugarcane country but not close enough to risk disease contamination from sugarcane fields. There the plantlets are grown just the way farmers grow sugarcane for seed. It's these stalks or seed pieces which farmers buy.

Why should farmers buy stalks when they can grow their own? "For the same reason potato farmers have been doing so for three-quarters of a century: They can make more money. We use the latest technology to give them disease-free stalks that are more vigorous and more productive than what they now grow," Carlson says.

Normally, tissue-culture propagation of plants is only cost effective for plants that are individually valuable such as apple trees or orchids. Carlson admits that his sugarcane plantlets are the most expensive sugarcane plants in the world. That's because of the number of tissue culturists Carlson has to pay to give the plants tender loving care.

But Carlson says tissue culture gives him such high-yielding sugarcane that it offsets the labor costs. This ability of tissue culture to grow plants that are more vigorous and more productive and have better growth characteristics is generally true for all plant tissue culture. Carlson and other scientists suspect it may have something to do with the growth hormones used in the medium.

Gillaspie says he's not sure whether that vigor will last from one crop to the next, but it doesn't matter because just eliminating disease is enough to do wonders for yields.

"Carlson's doing for sugarcane what was done for potatoes many years ago—producing seed pieces certified to be essentially disease-free," Gillaspie says. "The only difference is that he's doing it with tissue culture." Gillaspie is referring to the state programs designed to produce healthy potatoes, the first begun by the University of Wisconsin just before 1920.

Carlson—like others—has benefited from ARS research nationwide and the desire of the agency to share its experience with the public. For sugarcane, he looked at the agency's work being done in cooperation with the American Sugar Cane League, the Florida Sugar Cane League, and the Hawaiian Sugar Planters' Association.

For tissue-cultured apple trees, Carlson went to Richard H. Zimmerman, a plant physiologist at the ARS Fruit Laboratory in Beltsville. For the past several years, visitors to the research center have marveled at the sight of his laboratory-started apple trees growing on the slope of a hill overlooking rows of greenhouses. Zimmerman says an important task he and other ARS scientists face is to find out how apple trees and other tissue-cultured plants do in the real world outside the lab. "With trees you just can't see flowers and fruits in 1 year. It takes several years. Only then can you start testing, and you must test over a number of years—a minimum of 10," Zimmerman warns.

A tiny apple tree produced from tissue culture is held by plant physiologist Richard Zimmerman. (0286X275-12A)

Zimmerman planted his first tissue-cultured apple orchard in Beltsville in 1979 and added trees during the following 5 years. In the past few years, he has been sending trees throughout the United States for testing, even sending some to Canadian government agricultural researchers.

His oldest apple trees have grown outdoors for just 7 years, not enough time for a verdict. And peach trees only began to move outdoors a year ago, at Beltsville.

On the other hand, Zimmerman says that strawberries and thornless blackberries—because of the much

Horticulturist Olivia Broome examines cloned strawberries in growth chamber. (0286X238-6)

shorter time in which they mature and bear fruit—have been sufficiently field-tested.

Zimmerman agrees with Carlson that tissue-culture propagation is both an art and a science. "There's a lot of variability within species as well as between species. Take blueberries as just one example. Some cultivars are very easy and others are very difficult to grow with tissue culture. We don't know why."

Well aware of the risks as well as the rewards, Carlson is planning for success. For the near future, he is looking at the tissue-culture system developed for peaches by Freddi A. Hammerschlag, a plant physiologist with the ARS Tissue Culture and Molecular Biology Laboratory at Beltsville. Hammerchlag says that trees and shrubs are much more demanding to propagate than other plants. As one example, she found her peach tree plantlets refused to cooperate without a dose of "winter" each year—6 weeks in a refrigerator.

Mutations Are Both Good and Bad

But Hammerschlag has moved beyond propagation to focus on using tissue-culture techniques to search for peach plants that are more resistant than currently cultivated varieties to bacterial leaf spot disease. The disease is a major problem to East Coast peach growers because the bacterium that causes the disease thrives in humid summers and covers the fruit with black spots. It causes the leaves to drop and eventually kills the trees.

Tissue culture enables Hammerschlag to select plant cells rather than whole plants for disease resistance. She uses callus, tissue which is formed to heal wounds and is made up of cells that have not yet organized to form tissues and plant parts.

Hammerschlag uses callus because the unorganized cells frequently mutate in the growth medium. Mutations mean variety and that's what she and plant breeders work with.

The potential of tissue culture to induce mutations, an ability not yet understood, can be a problem when propagating a variety for commercial use. For example, a Delicious apple must be red with five lobes on the blossom end and have an overall elongated shape. Lose one of those characteristics and you don't have a Delicious apple.

Olivia C. Broome, an ARS horticulturist who grows tissue-cultured strawberries at the Beltsville Fruit Laboratory for researchers worldwide, says as long as tissue-culture

High-Tech Disease Detection

"Just because a plant is produced from tissue culture does not necessarily mean it is disease free," says Roger H. Lawson, research leader of the Florist and Nursery Crops Laboratory at Beltsville, MD.

Using the latest methods to detect disease, plant pathologists Ramon L. Jordan and John Hammond look into plant tissue for two of the smallest known disease-causing agents (pathogens): viruses and viroids. Viruses are infectious agents consisting of a segment or segments of nucleic acid surrounded by a protein coat. Viroids are smaller segments of RNA (ribonucleic acid) without a protein coat.

"Most virus and viroid diseases do not kill an infected plant but may make it unsalable by stunting its growth or damaging its fruit, flowers, or leaves," Lawson says. "The whole idea of producing tissue cultures that are pathogen free is to improve propagators are careful, they probably won't have to worry about mutations. In addition, the mutation threat is greatly reduced when propagators start with stable, organized tissue such as plant shoot tips rather than callus or cells.

Broome's work begins in the greenhouse, where she cuts off the ends of strawberry runners before they can fully develop into new plants. She takes the runner tips to her lab where the sterility begins with a bath in a mild household bleach and detergent solution.

Broome runs a lab whose sterility is only a little less than that of a hospital operating room. Her "operating room" is sterilized with ultraviolet light whenever it is unoccupied. When the door is opened, positive pressure from air flowing through large filters near the ceiling keeps any contaminants from entering. In one hand she holds a heat-sterilized surgical scalpel; in the other, a jeweler's forceps, sterile and sharpened specially to grasp the minute particle of living tissue she will remove for culturing.

Under a binocular microscope designed to aid dissecting, set to magnify 10 to 30 times, she begins to cut away at the living tissue. Aided by a measuring scale visible in one eyepiece, she carefully slices very thin cross sections, carving away unwanted tissue, until she reaches the meristem tip, the growing point of the runner.

When Broome finds the tip, she uses forceps to pick it up and very gently plant it top side up on the translucent medium in a jar, careful that it doesn't sink in and suffocate. Sitting on the medium, the tip looks like a grain of salt. The medium and the jar had previously been heat-sterilized.

The medium's recipe includes small amounts of the essential minerals found in fertilizers used by home gardeners. But Broome also adds other minerals, vitamins, sugar, and the all-important growth regulators, which are synthetic duplicates of natural plant growth hormones. A cytokinin hormone is used to induce the tissue to grow shoots, while an auxin hormone is used later to induce the formation of roots.

Sugar feeds the growing plants since they have neither sufficient light to photosynthesize nor roots to draw in nutrients—both needed to make food sugars in nature. The sterility ensures that the medium doesn't end up raising a bunch of fungi or bacteria as well.

---

crop quality and productivity."

One method that has been used by Jordan and Hammond and other Agricultural Research Service scientists to detect viruses and viroids is a technique called nucleic acid spot hybridization. Nucleic acids make up the genetic code for amino acids, the building blocks of proteins. And hybridization, Jordan explains, is the "joining of matching sequences of genetic material coming together like a zipper."

The zipper analogy is a good way to explain how genetic codes can be used to detect viruses or viroids in plants.

The genetic zipper has four kinds of teeth that make up a nucleic acid. When the DNA (deoxyribose nucleic acid) zipper splits, it leaves a strand of exposed teeth. A new RNA-strand of teeth matches up with the exposed teeth, but each tooth fits only with a complementary tooth. This strand of matching RNA is the code for selecting the strings of amino acids which make up proteins.

Since nucleic acid sequences are usually constant among specific pathogens, says Lawson, they can be used to identify specific nucleic acids in viruses and viroids. To detect these pathogens, a known virus' or viroid's RNA is used to make a strand of complementary DNA (cDNA) that will be able to recognize viral (or viroid) RNA in a plant-tissue extract.

Tissue extracts from a suspect plant are spotted on a thin membrane filter. The nucleic acid in the tissue extract is then immobilized by baking the filter. The filter is soaked in a solution containing the cDNA, which will hybridize to any complementary sequences of nucleic acids it finds. The cDNA and RNA of identical or related viruses and viroids "zip" together.

After the filter is washed to remove any unattached cDNA, the cDNA-RNA hybrids show up as dark spots on x-ray film that has been placed against the filter, because the cDNA has previously been made radioactive. A dark spot indicates that the virus or viroid is present in that tissue extract.

One way Jordan and Hammond use this technique is to detect and compare viruses infecting fruit and bulb crops. Another very important use of hybridization has been to routinely check seed potato lots for the presence of the potato spindle tuber viroid.

This specific application of the technique was developed and is used by Robert A. Owens and T.O. Diener, both with the ARS Microbiology and Plant Pathology Laboratory in Beltsville, and Luis Salazar with the International Potato Center in Lima, Peru.

Hybridization is one of the few techniques that can detect viroids, because currently used serological methods of virus detection rely on the protein coat which is absent in viroids.—By **Deborah Aksler,** ARS.

Roger H. Lawson, Ramon L. Jordan, and John Hammond are at the USDA-ARS Florist and Nursery Crops Laboratory, Bldg. 004, Room 101, BARC-West, Beltsville, MD 20705. ■

After the operation, the jar is placed on a shelf with many others, in a well-lit area. Temperature and length of light each day are carefully controlled. In 6 to 8 weeks, each tip grows into a strawberry plantlet. Then each plantlet is cut up and in 3 or 4 weeks, each piece will grow anywhere from three to eight more plants. Before the next month is up, each of those plants will again be cut up into pieces. And so on, every few weeks.

Plantlets grown from small meristem tips are usually virus free. There are several theories to explain this. One is that the meristem tip itself is virus free because it's isolated from vessels that could spread the virus. Another theory says the meristem tip may not be virus free but there may be something in the medium that acts as an antiviral agent. Or the meristem tips may grow so fast they starve any viruses that might have been present.

But beginning with disease-free plants isn't enough. Tissue culturists must keep the tissue and resulting plantlets free of disease as well. Broome advocates testing the first batch of plantlets for disease before mass-producing them.

While tissue culture doesn't guarantee disease-free plants, it gives growers the best chance to keep healthy plants healthy.

The propagation of horticultural plants is the main commercial use of tissue culture worldwide, because individual horticultural plants are so valuable. They're also most often vegetatively propagated through cuttings or grafts rather than grown from seed. Anyone who buys house plants such as the tropical ferns sold in supermarkets is probably buying a plant that got its start in a lab.

There are more than 200 tissue-culture labs in the nation that grow horticultural plants, with a total estimated production last year of 60 to 65 million plants. The potential for this production to grow is tremendous, considering the fact that in the past 2 years, several labs have expanded their production capacity to 15 or 20 million plants a year. This is more than the market can currently bear, so the development of new markets is a high priority.

Geneticist Brent Tisserat (left) and chemist Carl Vandercook check differences between growth of carrots in test tube and those in jar where growth medium is changed automatically without disturbing plantlets. (0985X987-20)

Tissue culture may well replace most forms of vegetative propagation, especially grafting, which Zimmerman describes as a "miserable job; it's hard to find people trained and willing to do it."

Grafters work in the hot summer sun, in pairs over a large field—one stooping or kneeling or crawling to make a cut or two in each rootstock and insert a bud in each cut, the other following to bandage the graft. The grafters usually use two buds per rootstock to double their chances of success. Even so, some will not grow into trees.

A tissue culturist works indoors and can turn one bud into hundreds of thousands of trees, each with their own roots. And if costs are kept down, each tree should be cheaper.

The biggest thing keeping costs up—and therefore holding tissue-culture propagation back—is the amount of labor needed to run a tissue-culture lab.

Automation to the Rescue

Automation is one solution to the problem of high labor costs. ARS scientists in California have found a way to automate their tissue-culture work and at the same time achieve at least two to four times the growth rate of conventional tissue-culture systems.

Plant geneticist Brent Tisserat and chemist Carl E. Vandercook use a computer to control the flow of liquid nutrients to plantlets. The nutrients flow through a network of tubing to plastic boxes or glass jars that house the growing plants. Tiny glass beads line the bottoms of these containers to keep the upper part of the plants above the solution.

Every 2 hours, all of the nutrient solution is automatically pumped out of the boxes into storage jars. The glass beads help the roots air out before the nutrient solution is cycled back to the plants.

Once a day, a small amount of the recycled solution is automatically drained from the storage jars and an equal amount of fresh solution is added.

"Our experiments with orchids, date palms, citrus, and other plants have consistently produced outstanding growth, typically two to four times that of conventional tissue-culture systems," Tisserat says. "The most dramatic growth has been with carrots, which traditionally do very well in tissue culture. With the automated system, they grew up to 15 times faster."

Besides speed, there is less risk of damage to tiny plantlets than with conventional techniques because there are no transfers. Tisserat explains: "Normally, plants have to be trimmed, subdivided, and moved to fresh nutrients in new test tubes at least every 2 to 8 weeks. With the automated systems, plantlets don't have this stress. They stay in one place until they are ready to be planted in pots or beds."

For Tisserat and Vandercook, the new system has a special advantage: They can keep plants—and plant parts—alive and growing for months longer than in traditional tissue culture. That's important, because they need to be able to follow subtle changes in the chemical composition of a plant as it grows.—By **Don Comis** and **Marcia Wood**, ARS.

A. Graves Gillaspie, Richard H. Zimmerman, Olivia C. Broome, and Freddi A. Hammerschlag are at the USDA-ARS Beltsville Agricultural Research Center, Beltsville, MD 20705. Brent Tisserat and Carl E. Vandercook are at the USDA-ARS Fruit and Vegetable Chemistry Laboratory, 263 South Chester Avenue, Pasadena, CA 91106. ■

Living Plant Libraries

Scientists throughout the world are turning to tissue-culture techniques to preserve important plant varieties.

At the Agricultural Research Service National Clonal Germplasm Repository in Corvallis, OR, scientists are using long-term storage of tiny bits of plant tissue for a backup to field plants and potted plants that could be destroyed by disease, drought, or other disasters.

Repository director Harry B. Lagerstedt says plants in the field or in pots take up a lot of space and are expensive to maintain: They have to be watered, pruned, sprayed, fertilized, heated in the winter, and repotted every year or two.

He says plants that would ordinarily fill a greenhouse can be stored in test tubes in one freezer-sized chamber. Cold storage for long periods allows living plants to perform more like seeds.

"A seed is a highly efficient way to store a plant," says Lagerstedt. "It's small, and storing it takes little or no maintenance. So it is with tissue culture."

While carefully manipulating temperature and light, the scientists devise recipes that dramatically slow the growth of plants. Lagerstedt says mint and strawberry tissue cultures in test tubes have been tucked away in refrigerators—at minus 1°C—for up to 2 years. When they were removed from cold storage, the plants resumed normal growth.

Scientists at the repository have also been freezing tissue, says Lagerstedt. "We take a flyspeck-sized piece of the meristem—the growing point of the plant—slowly freeze it to minus 30° or 40°C, and then drop it into liquid nitrogen at minus 196°C. At this temperature, a plant's life processes are so reduced their state resembles suspended animation."

One problem scientists have is getting plants to begin growing again after they've been stored in liquid nitrogen. "Although we're still in the experimental stage," says Lagerstedt, "our scientists at the repository are the first anywhere to have successfully regrown raspberries and blueberries that had been frozen in liquid nitrogen."

In a cold storage room at the National Clonal Germplasm Repository in Oregon, Harry Lagerstedt inspects tissue-cultured mint, strawberry, blueberry, and raspberry plants. (0286X271-29A)

But their greatest triumph in storing and reviving small fruits has been with strawberries—a 90-percent success rate! Because of this, Lagerstedt and colleagues have developed a 100-year-long experiment for storing strawberry meristems.—By **Howard Sherman**, ARS.

Harry B. Lagerstedt is at the USDA-ARS National Clonal Germplasm Repository, 33447 Peoria Road, Corvallis, OR 97331. ■

Elderly Cautioned on Overuse of Antibiotics, Antacids

Top: In research on the relationship of antibiotic and antacid use to anemia in the elderly, gastroenterologist Robert Russell samples fluid from a volunteer as nutrition biochemist Stephen Krasinski monitors stomach acid levels. (0286X124-4)

Above: Colonies of intestinal bacteria cultured in a climate-controlled chamber are counted by Krasinski and Russell (right). (0286X127-19)

Certain elderly people could suffer from anemia if they use antibiotics for prolonged periods or frequently take antacids at mealtime.

Recent findings indicate that both medications can reduce the body's uptake of folic acid—an essential water-soluble vitamin that aids in red blood cell production, says Robert M. Russell, M.D., acting director of USDA's Human Nutrition Research Center on Aging at Tufts University in Boston. The center is one of five Agricultural Research Service facilities commissioned to study dietary needs in people.

Antacids taken at mealtime simply neutralize the stomach acid necessary for absorption of folic acid, also known as folate or folacin.

Antibiotics, on the other hand, kill off intestinal bacteria that synthesize folic acid in the intestinal tract for people who can't absorb it from food. These people don't secrete enough stomach acid, which normally moves along with food into the upper intestine, providing the proper environment for the absorption of folic acid.

A significant number of elderly people have lost the cells in the stomach that secrete acid. The number ranges between 10 and 50 percent depending on which study is cited, Russell says. In his recent study in the Boston area, 20 percent of the over-60 population had this degenerative condition known as atrophic gastritis.

"The older a person is, the more likely he or she is of having atrophic gastritis," says Russell. A pepsinogen test—performed on a blood sample—is quite accurate in detecting this condition, but it is not commonly used in medical checkups.

"Our studies show that intestinal bacteria compensate for the loss of stomach acid and prevent the body from developing a folate deficiency," Russell says. The bacteria flourish in a nonacid environment and produce folic acid in amounts large enough to override the absorption problem, he explains.

Antibiotics, especially those that kill a wide range of bacteria, may destroy this backup system. "This could precipitate folic acid deficiency within weeks," says Russell.

Deficiency can cause anemia similar to pernicious anemia—the result of vitamin B12 deficiency. Symptoms include fatigue; shortness of breath; a sore, red, smooth tongue; and disturbances of the gastrointestinal tract such as diarrhea.

Russell says the findings also suggest that antacids can cause absorption problems if they are frequently taken with meals. Like atrophic gastritis, antacids reduce the acid environment the body needs to absorb folic acid from foods. However, since the nonacidic condition is temporary, folic acid-producing bacteria don't compensate as they do in people with atrophic gastritis.

Frequent use of antacids could lead to folic acid deficiency in any age group, Russell says, but this practice is more prevalent among the elderly.

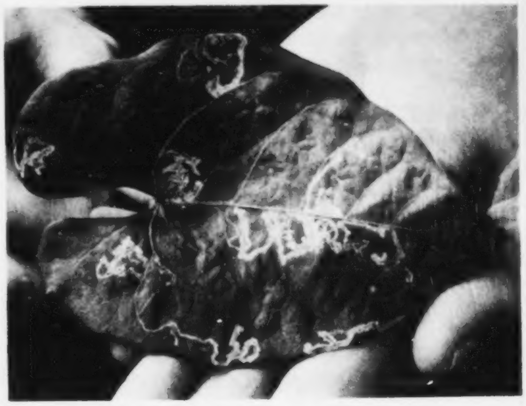
Russell says there is evidence that the loss of stomach acid may also reduce the body's uptake of vitamin B12 and calcium. He and colleagues at the USDA center are currently studying this issue.

"If 20 percent of our elderly have atrophic gastritis," he says, "we need to know how it affects absorption of vitamins and minerals. If it impairs absorption, then the dietary requirements would be higher for this group."—By **Judy McBride,** ARS.

Robert M. Russell is with Tufts University at the USDA Human Nutrition Research Center on Aging, 711 Washington St., Boston, MA 02111. ■

Natural Neem Kills Cockroaches and Greenhouse Pests

In his Beltsville, MD, greenhouse, entomologist Hiram Larew measures neem tree seedlings to determine rate of growth. (0386X401-16)



Leafminers left telltale evidence in this lima bean leaf. Maggots burrowed tunnels between the leaf's upper and lower surfaces, reducing photosynthesis. (0386X400-22)

Neem, a stylish tree of Asia and Africa, has yielded a new kind of insecticide for the United States.

Neem products killed or repelled insects on flower and nursery crops when sprayed on leaves or applied to potted plant soil, says Agricultural Research Service entomologist Hiram E. Larew.

Also, six common types of cockroaches were killed by neem-laced baits in other experiments by ARS entomologist Victor E. Adler.

"For centuries, neem leaves and seeds have helped people control insects in the Tropics," says Larew. "Now we're finding ways to use neem in U.S. agriculture."

As natural products, neem insecticides are probably biodegradable and environmentally safe for many uses, although only one has been approved by the U.S. Environmental Protection Agency for insect control on some horticultural crops.

In ARS tests by Larew, the product, called Margosan-O, controlled up to 95 percent of leafminers, a pest costing flower and vegetable growers over $15 million per year in California alone. Neem-based products for cockroach control are not yet approved by EPA, Adler says. However, in experiments he found that both Margosan-O and another lab-tested formula killed young cockroaches and limited egg laying by adults.

Larew says that research by USDA and other agencies in the late seventies showed that neem could control over 80 major insect pests. The work sparked wide interest by scientists in this country and abroad to develop neem products as possible replacements for some synthetic insecticides.

USDA's earlier studies showed that Japanese beetles would rather starve than eat some of their favorite plants that had been treated with neem, according to scientists at the ARS Japanese Beetle Research Laboratory at Wooster, OH.

When added to soil, neem compounds enter roots and move into plant leaves, making plants poisonous to leafminer worms, Larew says. The compounds interfere with the life cycle by somehow jamming hormonal signals for molting. The worms die trapped within their own skins.

Tropical neem trees are scarce in the continental United States but thrive throughout the Caribbean and could do well in southern Florida and Hawaii, according to ARS' Robert J. Knight. Neem, because of its insecticidal properties and high-quality oils, could be grown as a profitable crop by Caribbean farmers, suggests Knight.

About 50 neem trees are growing at research stations in South Florida, Knight says. Over 200,000 have been planted in Haiti in recent years to beautify public roadsides.

In tropical Asia and Africa, neem trees serve many purposes. The wood is used for timber. Leaves are used medicinally and as animal feed; bark is used to tan goat skins; leaves, small branches, and oilseed cakes become fertilizer. Twigs are even used for dental hygiene.

Neem
SWASTIK
NEEM SOAP
The Family Freshness Soap

Left, top: Neem-based insecticide is sprayed on a chrysanthemum to test its efficacy against leafminers. (0386X400-11)

Left: In India, there are commercially available products incorporating neem extracts. The fact that neem leaves have been used medicinally by people for centuries in India where the tree is indigenous suggests low toxicity for people and other mammals. (0386X403-7)

Above: Mature neem tree. (1178X1571-5)

Perhaps neem is most useful, though, for fighting insects. In India, Adler says, ground neem seeds are commonly added to stored grain to keep out insects.

Among the 80 insect pests inhibited by neem extract in research are Mexican bean beetles, Colorado potato beetles, North American grasshoppers, tobacco budworms, carpet beetles, striped cucumber beetles, confused flour beetles, milkweed bugs, citrus mealybugs, and navel orangeworms.—By **Stephen Berberich,** ARS.

Hiram Larew, USDA-ARS Nursery and Florist Crops Laboratory, B-470, and Victor E. Adler, USDA-ARS Insect Chemical Ecology Laboratory, B-476, are at the Beltsville Agricultural Research Center, Beltsville, MD 20705. Robert J. Knight is at the USDA-ARS Subtropical Horticulture Research Station, 13601 Old Cutler Rd., Miami, FL 33158. ■

Embryo Rescue Saves New Gene Combinations

By combining two genetic engineering feats—embryo rescue and chromosome doubling—a team of Agricultural Research Service scientists at Logan, UT, have created new plants not seen before in nature.

Geneticist Richard R-C. Wang and colleagues have already produced a new drought-resistant wheatgrass for western rangelands that yields 25 percent more livestock feed.

"With these techniques, almost any combination is possible," says Wang. The same strategy used for crested wheatgrass can be applied to other range grasses and even new wheat varieties. Hybrid embryos—formed by crossing species—are an avenue for transferring desirable genes among related plants.

Hybrids seldom occur naturally in the wheat plant family because the endosperm—the starch portion of the seed that nourishes the hybrid embryo—fails to develop.

"To ensure the embryo's survival," says Wang, "we cut part of the endosperm away from the underdeveloped embryo. Then, we artificially feed the embryo in agar, a plant gelatin containing nutrients. We hope it will then germinate and grow into a seedling, capable of supporting itself. Hybrid embryos take anywhere from 2 weeks to 4 months to germinate, depending on the species."

If the seed germinates, Wang checks the chromosome pairing in the new plant to see if it is sterile. "It's just like crossing a mare and a jackass to get a mule," says Wang. "The new offspring has the best attributes of its parents but only half the number of chromosomes it needs to reproduce."

To restore fertility in the grass embryos, Wang doubles the plant's chromosomes by treating the seedling with a chemical, colchicine.

One such creation is a new variety of crested wheatgrass, named Hycrest, developed by Wang's co-workers, geneticists Kay H. Asay and Douglas R. Dewey. It was released to plant breeders in 1984.

Hycrest is expected to yield at least 25 percent more grass for livestock and 20 percent more seed for reseeding western rangelands than other popular varieties.—By **Howard Sherman,** ARS.

Richard R-C. Wang is in USDA-ARS Forage and Range Research, Crops Research Laboratory, Utah State University, Logan, UT 84322-6300. ■

Lettuce, Melons, Grapes Travel Cooler

Fresh fruits and vegetables shipped in a new and improved refrigerated van will stay crisp and fresh longer. Because the van provides far better air circulation than conventional refrigerated vans, produce should arrive at its destination no more than 4 to 8 degrees warmer than when it left, according to Agricultural Research Service marketing specialist R. Tom Hinsch.

The uneven cooling that's common in conventional refrigerated vans can drastically shorten shelf life of produce and leave it more susceptible to rotting and similar problems. Asparagus kept at 32°F has a shelf life of 3 weeks; but hold it at 41°—a difference of only 9 degrees—and shelf life shrinks to just a week.

The new van—known as the Advanced Design Perishables Trailer—has been extensively tested using cross-country shipments of lettuce, melons, grapes, oranges, and other fresh fruits and vegetables. Among those who are well pleased with the results is Harold Bradshaw, manager of the California Iceberg Lettuce Research Program, Salinas—one of the many industry contributors to the van experiments. He comments, "This van will provide better air-temperature control than any other van on the road today."

Design features developed and tested by Hinsch and a team of university researchers and industry experts add $1,000 to $2,000 to the base price of a standard refrigerated van but solve these common problems:

- In a conventional refrigerated van, the part of the load that touches the sidewalls absorbs outside heat, even if the walls are insulated.

In the improved van, air from the refrigeration unit is forced through narrow, perforated channels that line the sidewalls—to keep the sides of the load evenly chilled.

- The intake area of the refrigeration unit is located just below the unit, in the front of the van.

The new van has a solid barrier open only a few inches at the bottom so warm air from the bottom of the load can move up through ducts to the intake unit for recooling. Further, unlike the open mesh, this solid wall prevents cool air that's blowing out of the unit from simply taking a shortcut directly to the intake below.

- Not enough air moves through the 1-inch-deep grooves that make up the floor of a conventional van to ensure that the bottom of the load stays cool.

Deeper, 2¼-inch, grooves in the new van provide better circulation underneath the load.—By **Marcia Wood,** ARS.

R. Tom Hinsch, formerly with USDA-ARS Quality Maintenance, Genetics, and Transportation Research Unit, Fresno, CA, is now at the USDA-ARS European Marketing Research Center, Rotterdam, The Netherlands. His mailing address is USDA, Agricultural Research Service, APO, New York, NY 09159. ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricltural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

PATENTS

A Better Way to Shake Trees

This mechanical "shake-and-catch" harvester handles fruit and trees more gently.

The mechanical jaw that grips and shakes the trees is prevented from damaging the trunks as it is withdrawn. A new design for the catching surface above the jaw protects the tree from scrapes as the catcher encircles the tree.

The new catching surface is a neoprene-on-nylon sheet stretched over a tubular steel frame, with tension controlled by springs. When taut, this surface breaks the fall of the fruit, avoiding bouncing damage.

For technical information, contact Donald L. Peterson, USDA-ARS Appalachian Fruit Research Station, Route 2, Box 45, Kearneysville, WV 25430. *Patent Application Serial No. 732.320, "Apparatus to Improve the Operation of a Continuously Moving Harvester for Tree Crops."* ■

Natural Preservatives

The pendulum is swinging back in favor of naturally occurring or derived antimicrobials and preservatives in food, medicine, cosmetics, and other products.

This is because of suspicions about the toxicity and side effects of the synthetic nonfatty compounds that have largely replaced the less potent fatty acid compounds used in the past.

The compounds described in these patents—new compounds derived from vegetable fatty acids and glycolic acid—offer a return to the safety of natural fats but retain potency of the synthetics. Lab tests showed several compounds inhibited the growth of *Staphylococcus aureus, Escherichia coli, Penicillium* mold, and *Candida utilis*—a yeastlike fungus commonly found in the human body.

For technical information, contact August V. Bailey or Gene Sumrell, USDA-ARS Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179. *Patent Nos. 4,346,043 and 4,347,378, "Antimicrobial Glycolic Acid Derivates."* ■

Permanent-Press Fabrics That Can Be Dyed

Formaldehyde compounds used to make cotton fabrics permanent press and wrinkle resistant also make the cloth difficult or impossible to dye.

That means the cloth has to be dyed before it is made into a permanent-press garment, restricting manufacturers' choice of colors.

This patent covers several nonformaldehyde finishing agents that make it possible to dye after the cloth is made and treated.

The finishing agent is dissolved in water, or a solvent that is mostly water, along with a mildly acidic substance to serve as a catalyst for the agent's reaction with the fabric.

For technical information, contact National Patent Program Coordinator (address below). *Patent Application Serial No. 774,698, "Dyed Wrinkle-Resistant and Durable-Press Cotton Fabrics."* ■

How to Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

34/5

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 5, May 1986

Agricultural Research

Trouble on the Range

Story on page 6

NEWARK PUBLIC LIBRARY
MAY 23 1986
U. S. GOVT. PUBS.
DEPOSITORY 376

A 77.12:

Research Would Boost Farm Profits, Exports

Current plans of the Agricultural Research Service call for taking aggressive new approaches to bolstering U.S. farm income and exports. Agency research from 1986 through 1992 will play an expanding part in combating the decline in farm income and exports. These are two of the most critical problems facing our country today.

We believe that a significant enhancement of farm income could result from development of new, commercial products made from surplus farm commodities. Also, research can improve the quality and acceptability of many U.S. farm commodities, making them more competitive in markets here and overseas.

In addition to these goals, the latest 6-year ARS research implementation plan directs scientists to make greater efforts to solve a number of national problems by:

- Increasing the number of interdisciplinary teams of scientists to encourage more innovation: A recent example of this team concept is the research group set up at the ARS Southern Regional Research Center in New Orleans to work on improving cotton fiber. In conducting this research, microbiologists and genetic engineers are working more closely than ever with traditional plant breeders to produce a higher quality cotton that can be more competitive with other fibers.
- Expanding plant germplasm programs: Since the turn of the century, thousands of crop plant varieties have been lost because they were not being used and propagated. To make sure that remaining germplasm is available to plant breeders in the future, we will strengthen a national system to collect, maintain, and distribute seeds and plant tissue. The ability to manipulate the genetic material within plant cells will be expanded as a prerequisite to developing more efficient crops and animals. A Plant Gene Expression Center in Albany, CA, is being opened to develop new genetic research techniques. In Maryland, a new biotechnology research center is planned in cooperation with the University of Maryland.
- Keeping pollutants out of groundwater: We are developing new and improved technology for preventing or reducing groundwater contamination by agricultural chemicals. This includes refinement of computer models to predict more accurately water movement down through the root zone as well as across the surface of the land.
- Conserving soil and water resources: We are developing new technology to control salinity and toxic elements in irrigation and drainage waters in the West. Another strategy with important implications in areas where water supplies are declining—such as the Great Plains' Ogallala aquifer—is helping farmers adapt to dryland conditions. Cotton plants with smaller leaves and denser rooting systems are one example.
- Fostering the use and development of computer-based information and data management systems in ARS: We will make increasing use of expert systems to transfer technology from scientists to users. These computer-based information systems will help farmers improve efficiency and increase profits. A 2-year pilot test of an expert system for cotton growers has shown that farm income can be increased by thousands of dollars per grower if the system's recommendations are followed.
- Reducing storage and processing costs of farm products: Mounting stocks of feed grains, for example, could be reduced by finding new industrial markets for starch. We're looking for ways to turn that starch into plastics, enzymes, soil conditioners, and chemical feedstocks. Other components of grain, such as proteins and vegetable oils, also have potential for making products such as paint and varnish.
- And protecting the quality, nutrition, and safety of America's food supply: We are searching for a more complete understanding of the relationships between nutrition and optimal health, with special attention to the problems of infants and children, mothers, and the elderly.

Problems facing agriculture constantly change and are increasingly complex, as is the research needed to solve them. Our latest plan outlines new strategies to help us cope with these complexities in the years ahead.—**Terry B. Kinney, Jr.,** Administrator

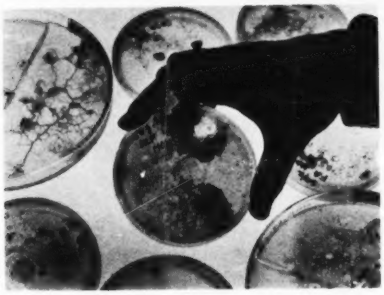
[Single copies of Agricultural Research Service Program Plan, 6-Year Implementation Plan, 1986-1992, are available from the Publications Branch, ARS Information Staff, B-005, BARC-West, Beltsville, MD 20705.]

Agricultural Research

COVER: Plants poisonous to livestock are found on all types of forage land, from high mountain range to lush meadow to arid plain. Animal physiologist A. Earl Johnson searches southern Arizona high country for threadleaf groundsel, one of many poisonous plants under study at the ARS Poisonous Plant Research Laboratory, Logan, UT. Story begins on page 6. (0386X459-33)

p. 6

p. 10



p. 12

6 Grazing Poisonous Plants

Many cattle, horses, and sheep do just that in western states each year. The Agricultural Research Service has a laboratory at Logan, Utah that gives top priority to preventing these losses.

8 New Clue to Livestock Poisonings

Enzymes in the liver designed to detoxify harmful chemicals actually create damaging compounds when livestock eat plants containing pyrrolizidine alkaloids.

10 New Chemical Bait Lures Yellowjackets

Keeping yellowjackets with their threatening stingers from swarming around your picnic table may someday be easier to do.

12 Molds, Mildew, and More

The world's largest collection of fungi is carefully cataloged in this laboratory near Washington, DC.

DEPARTMENTS

4 Agnotes

Taste Survey Rates Sweet Sandwich Mild
Dwarfed Sunflowers Easier To Harvest
Variety Is More Than Spice of Life
Soaked Seeds Grow Poorly

14 Technology

Drying Cotton With Waste Heat
Porkers' Hides Underused for Leather
Wind Tunnel Checks Spray Drift

16 Patents

Improved Seed Planter
More Effective Lure for Corn Borer Traps
Artificial Pheromones

Vol. 34, No. 5
May 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Taste Survey Rates Sweet Sandwich Mild

Onion lovers, get ready to crunch a new onion hybrid that's already wowed people in New York State.

In a 1984 survey, New Yorkers thought Sweet Sandwich more mild than Yellow Globe cooking onions by a margin of 78 percent. The new onion got its name because its mild taste and smell make it ideal for sandwiches and salads, says Clinton E. Peterson, a horticulturist with the Agricultural Research Service at the University of Wisconsin in Madison.

Home gardeners throughout the country can conduct their own taste tests this summer because Sweet Sandwich bulbs, seeds, and plants made their commercial debut in this year's seed catalogs.

The hybrid was released in 1982 by the U.S. Department of Agriculture and New York and Michigan Agricultural Experiment Stations. Commercial seed production began the following season.

In 1984 field tests in New York, Sweet Sandwich yields surpassed or equaled those of the most popular onion variety in the state. It also produced the large size preferred for mild onions.

Peterson also directed the breeding and testing of a sweet cucumber, the first truly resistant to a very destructive disease called bacterial wilt.

Besides being almost immune to the disease, the cucumber, County Fair 83, has the added advantage of not turning bitter even under severe stress caused by disease, drought, or inadequate soil nutrients.

County Fair 83 is ideal for home gardens, says Peterson, "Its mild flavor makes for better tasting salads and homemade pickles." These seedless cucumbers are slow maturing and don't lose color and soften on the vine as quickly as normal seed-producing varieties.

They are also resistant to scab, cucumber mosaic virus, powdery mildew, downy mildew, anthracnose, angular leaf spot, and fusarium wilt.

County Fair 83 has been tested successfully for several years in Wisconsin and Nebraska. Plant pathologist James R. Steadman and other University of Nebraska scientists worked with Peterson and ARS scientists to develop the new hybrid.

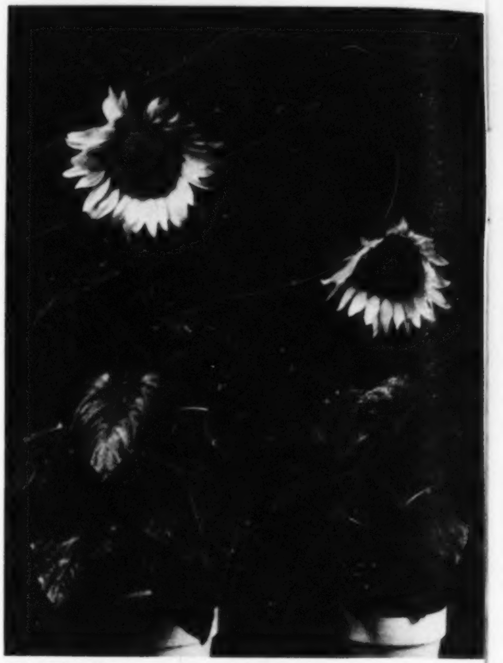
Peterson provided seed samples to home gardeners in widely scattered areas of the country. Their reports indicate the hybrid seems likely to become a popular cucumber.—By **Linda Cooke-Stinson** and **Ben Hardin,** ARS.

Clinton E. Peterson is in USDA-ARS Vegetable and Forage Research at the University of Wisconsin, Horticulture Department, 1575 Linden Drive, Madison, WI 53706. ■

Dwarfed Sunflowers Easier To Harvest

Sunflowers are more likely to hold their heads up for harvesting if their stalks have been dwarfed by a herbicide intended to kill wild oats, says Jeffrey C. Suttle of the Agricultural Research Service. Normal-height plants tend to topple during windy, wet weather, particularly when the heads become heavy with ripening seeds.

Suttle, a plant physiologist in Fargo, ND, has found that the herbicide difenzoquat temporarily slows cell division in young sunflower stalks. Sunflower seedlings sprayed with this chemical grew only two-thirds as tall as untreated plants but matured normally otherwise.


Planted at the same time, sunflower on right was treated with difenzoquat 6 days after emerging, causing reduced stem growth. Sunflower on left was untreated. (PN-7203)

"The growth-regulating properties of difenzoquat are not surprising," Suttle says, "when one realizes that several currently registered agricultural chemicals now used as bioregulators were initially used as herbicides." He cautions, however, that difenzoquat is not approved for growth regulation on sunflowers.

Examples of dual-purpose chemicals in use include glyphosate, used as a sugarcane ripener; mefluidide, used to retard turfgrass; and 2,4-D, used as a hormone supplement in plant tissue culture.—By **Linda Cooke-Stinson,** ARS.

Jeffrey C. Suttle is at the USDA-ARS Metabolism and Radiation Research Laboratory, State University Station, P.O. Box 5674, Fargo, ND 58105. ■

Variety Is More Than Spice of Life

Of the approximately 8,000 apple varieties known in 1905, all but about 1,200 have been lost. A similar tale could be told for grapes, with the losses continuing today. When a variety is lost, so too are the gene combinations people spent years breeding. Even worse, it means the lost variety's genes—along with their unknown qualities—are likely to be found only in wild plants that could become extinct.

To save the genes of apple and grape varieties and their wild ancestors in North America and the Middle East, the Agricultural Research Service and the New York State Agricultural Experiment Station in Geneva, NY, recently opened the National Clonal Germplasm Repository for Apples and American Grapes.

The repository is fittingly located in the heart of the Finger Lakes region, the center of New York State's thriving fruit industry. New York ranks second in the United States in production of both apples and grapes.

Special facilities are needed to preserve the germplasm (genes and other hereditary materials) of plants that are clonally propagated. This is because the gene combinations that characterize each apple or grape variety are not transmitted faithfully through their seeds. They must be propagated from cuttings or grafts, requiring the storage of living plants or tissue rather than seeds.

The $1 million repository at Geneva covers 8,000 square feet including greenhouses, laboratories, office space, and other facilities. It will maintain both wild and domesticated apples and grapes in the greenhouses and on about 50 acres of orchards and vineyards.

Scientists at the repository will study and catalog the plant varieties for characteristics such as resistance to insects and disease. The repository will share its plant materials with breeders and other researchers in this country, as well as those in countries that have reciprocal exchange programs.

Philip L. Forsline, curator of the new clonal repository at Geneva, says the Geneva Station was chosen for the repository because it has a 104-year history of maintaining and breeding an extensive collection of fruit germplasm.

The repository shares space with the ARS Northeast Plant Introduction Station, which was set up in the early 1900's to maintain germplasm for vegetables, forage grasses, and some ornamentals.—By **Don Comis**, ARS.

Philip L. Forsline, a USDA-ARS horticulturist, is the curator of the National Clonal Germplasm Repository, New York State Agricultural Experiment Station, Geneva, New York 14456. ■

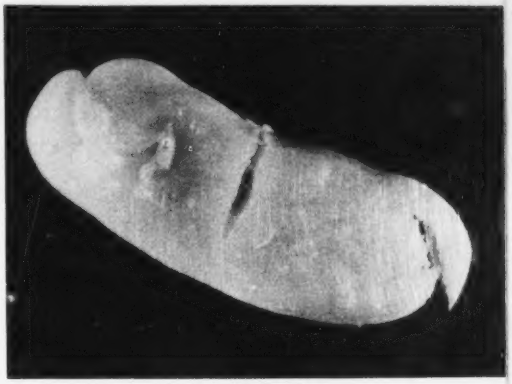
Soaked Seeds Grow Poorly

Contrary to popular belief, soaking seeds to get them off to a fast start may actually do more harm than good. Normally, when a seed is planted, it takes up water from the soil and forms a root tip, which pokes a tiny hole in the seed cover. Thus, the developing plant is free to expand and grow.

However, if the seed is soaked or the ground is too wet, the seed takes up water too quickly, and its cover cracks. These fractures allow whatever is inside—amino acids, proteins, and sugars—to leak into the surrounding soil.

At that point, disease-causing soil fungi—nourished by the leaking seed—begin to infect the young, highly susceptible seedling.

Leakage is a big problem with grain and legume crops, not because of presoaking, but because they may be sown in wet soil or rains may come soon after planting. These plants never completely recover, says plant physiologist Stephen C. Spaeth with the Agricultural Research Service in Pullman, WA.



Cracks in bean cotyledon after soaking in water. (PN-7205)

Using a stress measuring instrument he designed, Spaeth studied fracturing characteristics of many kinds of seeds. He found that the cotyledons—seed parts that supply young seedlings with food—elongate very slowly as stress builds and the seed is stretched. As moisture builds up, the cotyledon cracks—much like the cracking one sees and hears when an ice cube is dropped into a warm drink.

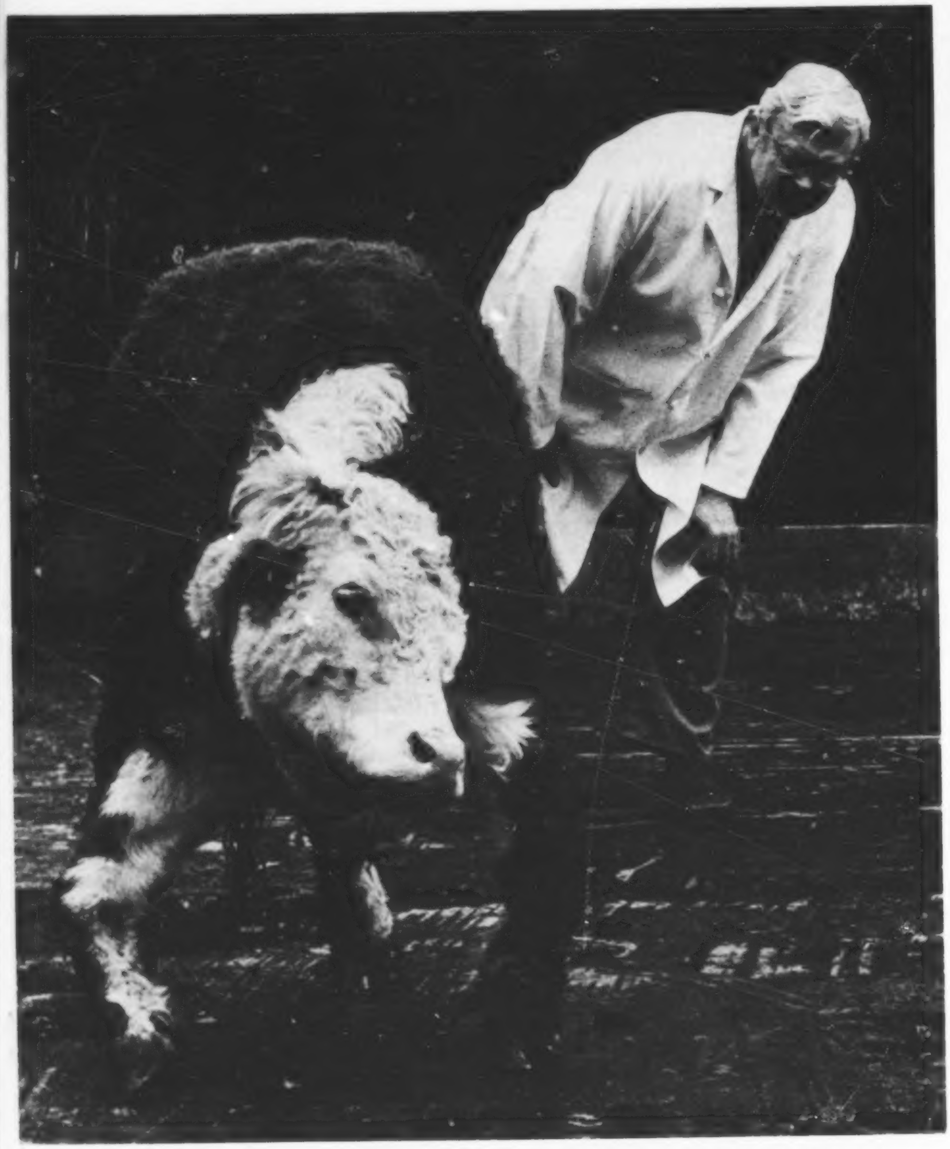
Two methods are available to farmers now to reduce seed fracturing. One is to delay planting to avoid the moist field conditions that promote fracturing. But this practice shortens growing time and can reduce crop yields.

The other way to prevent fracturing is to place the seeds in a special moisture-controlled room to gradually raise their water content before planting. But for large-scale agriculture, this technique is costly.

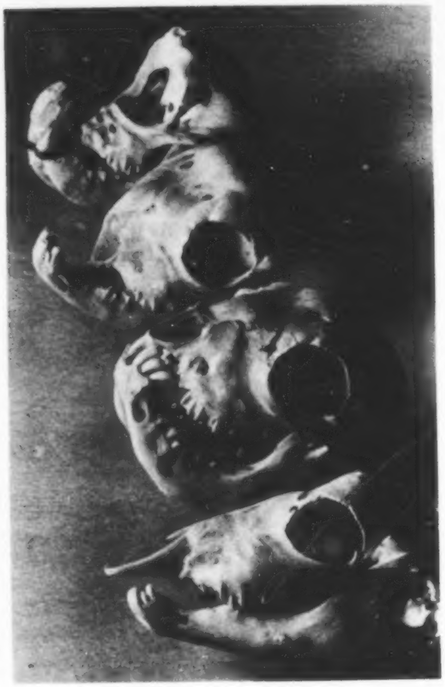
A new, less expensive method, still at the experimental stage, looks promising, says Spaeth. It involves coating seeds with a waxy compound that slows water uptake and prevents fracturing.—By **Howard Sherman**, ARS.

Stephen C. Spaeth is in USDA-ARS Grain and Legume Genetics and Physiology Research, Johnson Hall, Washington State University, Pullman, WA 99164. ■

Grazing Poisonous Plants



Above: Chemist Richard Keeler inspects a steer suffering from "crooked calf disease" induced when the pregnant mother ate lupine, a poisonous plant, between the 40th and 70th days after breeding. The condition is usually characterized by deformed front limbs and curvature of the spine or neck. (0386X461-24)



Top, right: Ingestion of false hellebore by pregnant sheep on day 14 of gestation causes severe facial deformities as these top three skulls attest. The bottom skull is from a normal animal. (0386X466-4A)

Just after sunrise one clear day in January 1971, sheep herders near Garrison, UT, awoke to a grisly sight. More than 1,200 ewes lay dead—scattered about the gently sloping hillside where they had bedded down the night before.

Within hours, scientists with the Agricultural Research Service were at the scene inspecting the area, taking photographs, and collecting tissue samples from the dead sheep for analysis. A few days later, their laboratory tests determined what they had immediately suspected. The sheep had eaten leaves containing oxalates, the principal poisonous compound of halogeton, a fast-growing annual weed.

The scientists learned from the foreman of the sheep herders that the day before the ewes died, he had guided the flock through about 20 acres of range heavily infested with halogeton. He knew the plants were poisonous, so he moved the sheep away from the deadly plants to a place about half a mile away where he felt they would be safe for the night.

According to one scientist, the sheep must have awakened hungry during the night and wandered back to the halogeton-infested site. "Those plants were about one-third pure poison," he says. "It probably took only a quarter pound of leaves to kill the ewes, maybe 3 or 4 mouthfuls. The sheep must have died within 4 hours."

> **"Each year, livestock losses related to poisoning cost ranchers in the western states more than $190 million."**
> —Lynn F. James

This type of scenario is replayed a number of times a year throughout the West, although the results are usually not as severe.

To help prevent these losses, seven ARS scientists make research into the effects of poisonous plants on livestock the top priority at the ARS Poisonous Plant Research Laboratory—the only one of its kind in the world.

At any one time, scientists at Logan, UT, are studying 15 or 20 plant species that can cause a range of disorders from birth defects to death.

The scientists' job is to identify specific toxins in poisonous plants, describe symptoms of poisoning, and develop new methods for cutting livestock losses from poisoning.

"Each year, losses related to poisoning affect 3 to 5 percent of the cattle, sheep, and horses that graze western ranges and cost ranchers in those states more than $190 million," says lab director Lynn F. James. "The West abounds with shrubs, grasses, and trees that can cripple, kill, cause abortion, and in many other ways interfere with livestock production. And while humans can choose to avoid poisonous plants, animals often cannot."

"Halogeton is a good example of a bad plant," says M. Coburn Williams, plant physiologist at the laboratory. It was discovered near Wells, NV, shortly after it found its way into this country from Asia in the early 1930's and now infests over 12 million acres of desert range in at least seven western states.

The trouble with an undesirable, fast-growing plant like halogeton, is that by the time it is recognized as a problem, it may be well established. Controlling these plants is extremely difficult and costly, if not impossible, given the vast spaces involved and the difficulty in reaching them.

Research by James shows that sheep can safely graze small amounts of halogeton without apparent harm because bacteria in their stomachs can break down limited amounts of oxalate, making it harmless. But hungry sheep allowed to graze heavy growths of halogeton in a short period can be fatally poisoned.

The solution? "Make sure the sheep are well fed and watered before moving them through range infested with halogeton," James says.

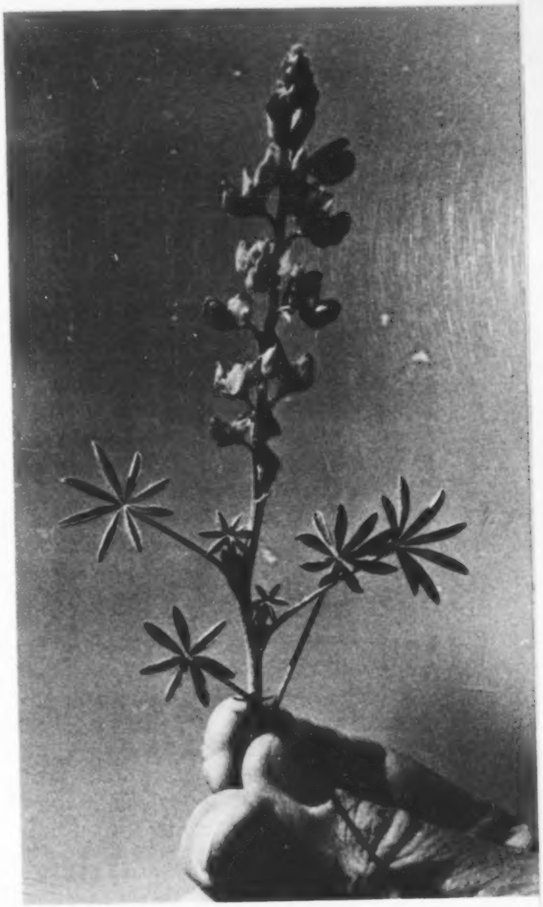
As a direct result of James' studies, ranchers have devised management plans that have cut their livestock losses due to halogeton in half.

What other advice does James have for ranchers?

- As soon as livestock have grazed the most desirable plants, move them from the area. (Otherwise, they will be forced to eat plants that may be poisonous.)
- Don't allow overgrazing even where poisonous plants are not present. It encourages them to invade the weakened rangeland.
- Spend more time walking around fields. Driving a pickup around isn't the best way to identify weed problems.

Poisoning the Next Generation

Chemist Richard F. Keeler's work provides another example of damage caused by poisonous plants. If pregnant ewes eat leaves of the false hellebore plant—a member of the lily family that grows in wet meadows and forests—they may have severely deformed "monkey-faced" offspring with protruding jaws and various eye defects including a single "cyclopic" eye.


Several members of the *Lupinus* genus are responsible for "crooked calf disease." The plants are recognizable by their "pea family" shaped flowers and compound leaves with multiple leaflets. (0386X467-36)

"Strangely enough," says Keeler, "our research showed that these deformities are produced only if ewes happen to eat false hellebore on the 14th day after conception."

Still further research by Keeler and colleagues revealed that eating false hellebore leaves 19 to 21 days after conception causes early embryonic death. And eating the

Animal scientist Kip Panter collects blood samples for hormonal and biochemical analyses of ponderosa pine needle abortion in beef cattle. (0386X460-28)

leaves during days 27 to 33 causes tracheal stenosis, a condition in which lambs die immediately after birth because they are born with their windpipes completely collapsed.

As horrible as the effects of eating false hellebore may be, they can be prevented with a simple management strategy. "Keep sheep away from the plant until all ewes have passed their 33rd day of pregnancy," says Keeler. That's the message that went out to sheep ranchers as a result of this research.

Keeler says the results of the sheep study at Logan agree with those of a human study by scientists at the National Institutes of Health in Bethesda, MD—namely, that cyclopomene, a toxic substance found in false hellebore, indirectly causes birth defects by inhibiting the synthesis of proteoglycan, a component necessary for cartilage development.

Keeler and co-workers are also exploring other links between plant poisons and birth defects in sheep, cattle, and pigs. He believes this type of research not only reduces problems for ranchers, but could serve as an excellent model for studying similar birth defects in humans.

Another problem for ranchers is abortion caused when cows eat needles from ponderosa pine trees, found in all 17 western states.

Cows that graze even small amounts of pine needles during the last trimester of their pregnancy may abort and die from complications. Abortion can take place anywhere from 2 days to 2 weeks from the time the animal eats the needles, says James.

A Deadly Sunburn

Some plants cause a painful type of sunburn that can kill light-skinned animals, says animal physiologist A. Earl Johnson. These phototoxic plants contain a substance that makes skin ultrasensitive to sunlight. When animals—especially sheep—eat the plants, they absorb the phototoxic compounds, which are

---

New Clue to Livestock Poisonings

A previously unsuspected chemical may play a key role in causing hundreds of wild plants throughout the world to be poisonous to animals and people.

"The chemical is produced when plant compounds known as pyrrolizidine alkaloids come in contact with enzymes in the liver," says William F. Haddon, a chemist with the Agricultural Research Service in Albany, CA.

Haddon and a team of University of California at Davis researchers are the first to discover the possible role of this chemical, *trans*-4-hydroxy-2-hexenal, in plant poisonings. The university team included H.J. Segall and D.W. Wilson of the School of Veterinary Medicine, and J.L. Dallas, Department of Biological Chemistry.

Haddon says the new findings challenge previous theory, widely accepted by toxicologists and veterinary medicine researchers, which attributed the poisoning exclusively to compounds known as pyrroles.

The discovery of the role of *trans*-4-hydroxy-2-hexenal in pyrrolizidine alkaloid poisoning should help researchers develop an antidote.

Pyrrolizidine alkaloids, which occur naturally in many weeds that grow throughout the United States and other countries, kill horses, cattle, pigs, and other livestock by causing cumulative and irreversible damage to the liver. In humans, cases of pyrrolizidine alkaloid poisoning are rare. One cause of poisoning in this

Left: Keeler examines a molecular model of cyclopomene, an alkaloid compound from false hellebore. Identified by Keeler, the compound's structure and configuration are critical to birth defects caused by false hellebore. (0386X460-14)

Above: In greenhouse studies, range scientist Michael Ralphs (left) and plant physiologist M. Coburn Williams grow western wheatgrass to test for selenium levels. Many rangeland plant species, including western wheatgrass, have the ability to accumulate toxic levels of selenium which can cause infertility, loss of hair, sloughing of hooves, and death in livestock. (0386X463-15)

absorbed and circulated in the blood to the capillaries of the skin, where they are activated by the sun's rays.

This type of poisoning causes everything from abnormal redness and blistering of the skin to ulceration, gangrene, and permanent disfigurement. Animals eating these plants may also become blind and, as a result, often die of starvation and thirst.

Johnson says the horsebrush plants cause more sheep losses than all other phototoxic plants combined. Other wild plants responsible for sunburning include spring parsley, wild parsnip, and St. Johnswort.

Spring parsley, for example, thrives at the height of the lambing season before many other plants have begun to grow. Animals do not die directly from eating spring parsley, but a ewe's udder may become so inflamed and tender that she refuses to let her lamb nurse, and it starves to death.

Spring parsley is native to the West. But a large number of poisonous plants, like halogeton, got here from other countries, either purposely or through carelessness.

Beware the Late-Summer Groundsel!

Threadleaf groundsel is a native sagebrush-like plant in the sunflower family. It is one of the most common poisonous plant in the Southwest.

---

country has been homemade teas made with wild plants that contain these alkaloids.

The chemical is a metabolite, or byproduct. "The enzymes of the liver transform pyrrolizidine alkaloids into this toxic metabolite," Haddon says. "Normally, the liver acts as a detoxifier, secreting enzymes that reduce the toxicity of ingested material. But in the case of pyrrolizidine alkaloids, the enzymes have—tragically—the exact opposite effect."

Haddon says that the chemical structure of the newly found metabolite is "almost identical to that of a metabolite formed in livers of laboratory animals exposed to carbon tetrachloride or bromotrichloromethane, two commonly used industrial chemicals." He notes, "This parallel may give us some new insights on liver disease."

The metabolite was found during laboratory analyses of chemicals produced when a pyrrolizidine alkaloid extracted from a small flowering weed known as common groundsel *(Senecio vulgaris)*, was exposed to a mixture of liver enzymes.

The researchers used three types of laboratory analyses—high performance liquid chromatography, gas chromatography, and mass spectrometry—to obtain a precise picture of the chemicals that resulted from the interaction.

The discovery was reported in *Science* magazine August 2, 1985.—By **Marcia Wood,** ARS.

William F. Haddon is at the USDA-ARS Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710. ■

Johnson and Russell J. Molyneux, a chemist at the ARS Western Regional Research Center in Albany, CA, were the first to find seasonal variations in the amounts of pyrrolizidine alkaloids in threadleaf groundsel.

Pyrrolizidine alkaloids are converted into toxins by enzymes in an animal's liver. Over time, these toxins cause severe liver damage similar to the effect excessive alcohol can have on a human liver.

Lab tests by Johnson and Molyneux showed levels of the chemical are exceptionally high when the plants are in the bud and early flower stage, usually in late summer. Livestock are relatively safe from poisoning in the winter when concentrations of pyrrolizidine alkaloids in plants are low.

Groundsel, as well as halogeton, false hellebore, ponderosa pine, spring parsley, St. Johnswort, horsebrush, and many other poisonous plants are described in a full-color publication, "Plants Poisonous to Livestock in the Western States," USDA Agriculture Information Bulletin 415. While the supply lasts, single copies are available free on request to the Poisonous Plant Research Laboratory.—By **Howard Sherman,** ARS.

Lynn F. James, A. Earl Johnson, Richard F. Keeler, and M. Coburn Williams are at the USDA-ARS Poisonous Plant Research Laboratory, 1150 E. North, Utah State University, Logan, UT 84321. ■

How Do You Handle Poisonous Plants? Don't!

Although their main work is with livestock poisoning, scientists at the Poisonous Plant Research Laboratory are often called upon to lend their expertise to doctors treating human victims.

The Poison Control Center in Salt Lake City, UT—one of many U.S. centers whose personnel respond to acute emergencies by phone—refers many cases of plant poisoning to the lab, particularly when a plant must be quickly identified so doctors can treat the victim. Each year in the United States, more than 12,000 children and adults are poisoned by plants.

Scientists at the poisonous plant lab caution people that many ornamentals produce berries, nuts, beans, or fruits which are attractive to children but deadly if eaten.

Toxic plants such as dieffenbachia are better omitted as house plants if there are small children in the family. And poisonous garden plants such as foxglove, larkspur, and young rhubarb should be relegated to less accessible parts of the garden. Castorbean, which has attractive—but deadly—seeds, is better not used as an ornamental until children are old enough to understand the dangers of poisonous plants.

Oleander—widely used as an ornamental in parks, along fences, and in yards—is one of the most toxic plants known. It contains heart poisons called cardiac glycosides. People have died from eating marshmallows or hot dogs skewered on an oleander branch. And yellow oleander, aptly called the "be-still tree," is the most frequent cause of plant poisoning in Hawaii because of its use as a folk medicine.

Those faced with a plant poisoning should be prepared to describe the plant as well as the amount and part eaten. Samples of the plant should be saved. People should also be sure to follow a physician's directions for treatment. Don't assume the plant was not poisonous because there are no immediate symptoms. Toxic symptoms may not appear for several hours, and then it may be too late.—**H.S.** ■

New Chemical

Keeping yellowjackets with their threatening stingers from swarming around backyard picnic tables may someday be easier to do. An Agricultural Research Service scientist has developed a chemically baited trap to catch them.

Entomologist Jeffrey R. Aldrich lures the most menacing types of yellowjackets in the eastern United States into traps using a blend of artificial, nontoxic chemicals similar to a natural insect pheromone, or attractant. It is most effective in spring and early summer, when the sweet-smelling chemicals attract yellowjacket queens before they establish nests.

"If queens can be captured before they make nests, then they can either be killed or moved so they establish colonies in woods, fields, and other areas away from people," says Aldrich, who works at the ARS research center in Beltsville, MD. "The traps can also be used in late summer and fall to catch yellowjacket workers after a colony has started."

Some species of yellowjackets are a nuisance to people, but they also play a valuable role as predators, feeding on flies, caterpillars, and other insects.

"It's hard to convince people who have been stung by yellowjackets that they are beneficial insects, but they are," says Aldrich. "Yellowjackets prey on other insects and do a small amount of pollinating."

Aldrich says his chemicals and

Bait Lures Yellowjackets

Top, left: Eastern yellowjacket queen. (0684W751-4)

Above: To lure yellowjackets, entomologist Jeffrey Aldrich loads insect trap with a chemical attractant. (0386X427-27)

trap work particularly well against the eastern and German yellowjackets, among the most menacing types in the eastern United States. Other attractants have worked against the western yellowjacket but have been ineffective against yellowjacket species in eastern North America.

In field tests, Aldrich used several types of traps hung at shoulder height on tree branches along borders of woods and pasture areas. The chemicals inside are either a sticky liquid or part of a small plastic pellet.

Aldrich caught queens from two of the most pesky species—the eastern and German yellowjackets. He says the chemicals are better than current attractants, which include cat and dog food. His baited traps will be most effective in urban and suburban areas, he says, where there are fewer queens.

Aldrich's chemical blend has the same major ingredients that are in a pheromone from a predatory insect called the spined soldier bug. (See Patents, p. 16, this issue.) While testing artificial attractants for this member of the stink bug family, Aldrich found that certain types of yellowjackets were also attracted to the bug's pheromone. He is not sure exactly why, but he has two theories.

One is that the yellowjacket responds to the pheromone because it wants to steal the stink bug's prey. The other is that yellowjackets are drawn to the pheromone because it smells like chewed tree leaves, where yellowjackets often find insects on which to feed.

The eastern and German yellowjackets eat other insects but also scavenge in garbage and at picnic tables for food and, if disturbed, can sting humans. They are particularly threatening because they can nest in buildings as well as underground and because their colonies are large—up to 4,000 or 5,000 to a colony. Also, yellowjackets, unlike honey bees, can sting repeatedly and stay alive.

"The one or two yellowjackets that may sting you during a barbecue or in your backyard, for example, will not seriously hurt you, unless you are allergic to their venom," Aldrich says.

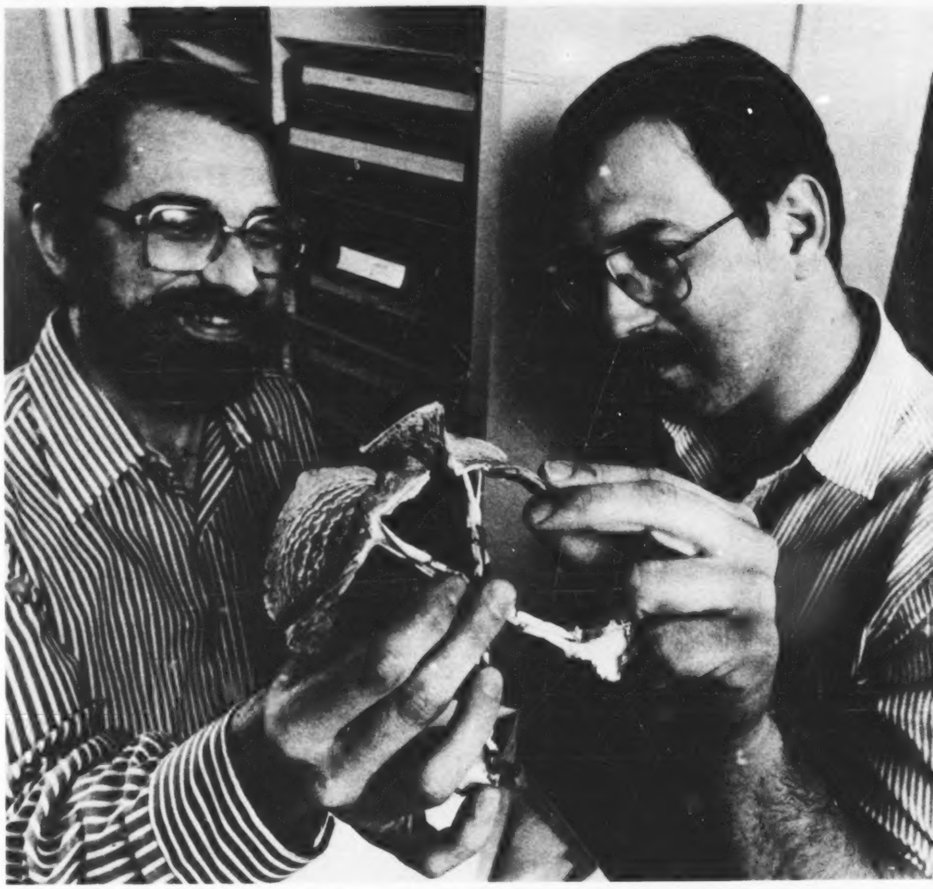
"But if a child stepped on an underground nest, or if you ran over a nest with the lawnmower, that could be a life-threatening situation. Having a few hundred yellowjackets coming after you is dangerous."

One advantage of his method, Aldrich says, is that the chemical pheromone only attracts yellowjackets that are about 3 feet away from the trap. That means once yellowjackets in the immediate area are caught, others from farther away won't be drawn to it.

Aldrich has been field-testing the chemicals at Beltsville over the last several years, seeking a chemical blend that not only catches yellowjackets but that does not harm honey bees. He says honey bees are generally not strongly attracted to the chemicals.—By **Sean Adams,** ARS.

Jeffrey R. Aldrich is at the USDA-ARS Insect and Nematode Hormone Laboratory, Bldg. 467, BARC-East, Beltsville, MD 20705. ■

Molds, Mildew, and More



Dried *Amanita*—a deadly mushroom known as the "destroying angel"—is examined by botanist David Farr (left) and technician James Plaskowitz. (0386X491-36)

Late one Sunday night in August 1985, a 2-year-old child was rushed to the Washington, DC, Children's Hospital after having eaten a mushroom believed to be poisonous.

Since the mushroom had not been identified, physicians were unsure of how to best treat the child. They put in an emergency call to fungus specialist David F. Farr, co-curator of the Agricultural Research Service's National Fungus Collections (NFC), at his home.

By 1:00 a.m., a portion of the mushroom had been flown by helicopter to the ARS Systematic Botany, Mycology, and Nematology Laboratory in Beltsville, MD, where the Collections are kept.

Farr immediately began his identification—cutting off the mushroom's cap and sifting its spores onto a sheet of white paper. After careful examination, he was able to say that it was only *Lepiota molybdites,* not the nearly indistinguishable *Amanita*—a toxic mushroom often called the "destroying angel." *Lepiota molybdites'* unusual green spores helped Farr identify it as a species which produces stomach upset and nausea but no lasting effect.

Medical emergency identifications like this one are handled about three or four times a year, according to Amy Y. Rossman, research leader for the mycology lab. Rossman, who is also co-curator, says the National Fungus Collections' primary purpose is to provide information about fungi and their hosts to researchers and specialists in the United States and worldwide. The Collections make up the largest fungal herbarium in the world. As many as 10,000 of the nearly 1 million dried specimens are lent out for identification purposes each year.

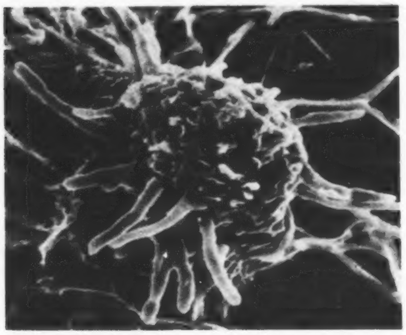
Not all fungi are harmful. Some beneficial species actually protect plants from disease-causing fungi. Rossman says that using information from the NFC can aid scientists in discovering how to best use these beneficial fungi to protect plants and animals from fungal disease.

The mycology lab also serves as a sort of Bureau of Standards for mycologists all over the world. Often, if there is a dispute over the name or other feature of a certain species of fungi, concerned scientists can refer to the type specimen in the NFC to settle the matter.

The NFC fungi are dried for durability and ease of storage. The oldest specimens are preserved in leather-bound books, called exsiccati, dating as far back as the early 1800's. The agency's live fungus collection is housed at the ARS Northern Regional Research Laboratory in

Slime molds in the National Fungus Collection are being tested as possible biocontrol agents against other fungi. (0386X498-20)

In the Stevenson Reference Room, mycologist Amy Rossman studies a rare volume on mushrooms. (0386X494-13)



Magnified 1,050 times, this spider-like fungus called *Uredinophila* occurs naturally on various harmful rusts and may have potential as a biocontrol agent. (Scanning electronmicrograph by James Plaskowitz) (PN-7204)

Peoria, IL, and contains about 33,500 specimens.

Ten to fifteen thousand new specimens are added to the NFC each year. Incoming specimens are frozen to rid them of any pests they may carry. The freezing method is fairly new to the mycology lab—in the past, chemicals such as naphthalene (found in ordinary moth balls) were used for fumigating specimens.

Considerable information about each specimen is stored in the NFC, and until recently there was no easy way to access it. In order to speed handling of requests, a six-person team, headed by Farr, has begun putting the name and description of every specimen into a computer.

This is the first computerized fungus data base in the United States, says Rossman, although not the only one. Scientists at Purdue University's (West Lafayette, IN) Joseph Arthur Herbarium and at the New York Botanical Gardens are following the mycology lab's lead with their own collections.

Computerizing the NFC is expected to take several years, Rossman says. So far, the rusts and smuts have all been entered, along with most of the polypores, or wood-decay fungi. Still to go are over 600,000 specimens in the ascomycetes (such as yeasts, mildews, and truffles), fungi imperfecti, and slime mold groups.

When that job is complete, plans call for entering the lab's fungus-host index—presently on 1.5 million 3- by 5-inch cards. Rossman says the fungus-host index is used to determine the kinds of fungi that grow on a specific plant—jack o'lantern fungus on oak trees, for example. Or, starting with the name of a particular fungus, a user could find out which plants it grows on.

Besides the computerization project, researchers at the mycology lab are revising a 1960 U.S. Department of Agriculture publication, "Index of Plant Diseases in the United States." It is expected to be ready for release in 1988.—By **Caree Lawrence,** ARS.

Amy Y. Rossman and David F. Farr are at the USDA-ARS Systematic Botany, Mycology, and Nematology Laboratory, Room 313, Bldg. 011A, BARC-West, Beltsville, MD 20705. ■

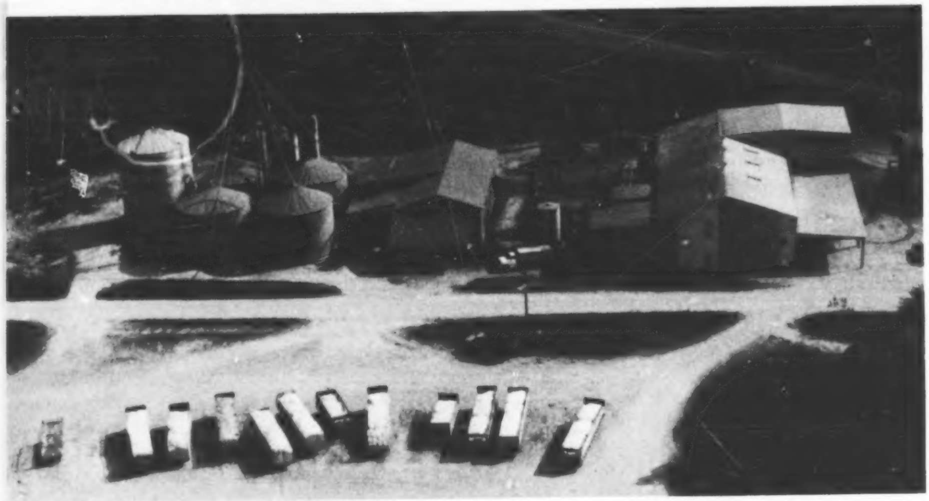
Still Growing, a Century Later

The National Fungus Collections grew out of specimens acquired on government-sponsored expeditions in the 1800's. Officially established in 1869 as the Pathological Collections, the herbarium has grown from some 14,000 specimens in the late 1800's to about 1,000,000 today.

The National Fungus Collections have been supplemented over the years with herbaria from major institutions, including the Smithsonian Institution, the Brooklyn Botanical Garden, the Missouri Botanical Garden, and the Chinese National Herbarium. They also contain the private collections of several famous persons, among them American botanist George Washington Carver, who is better known for his work with peanuts, including the invention of peanut butter.

The Stevenson Reference Room, also part of the mycology lab in Beltsville, houses the personal library of the late John L. Stevenson, a mycologist at USDA for many years. The collection contains about 7,000 books and journals and about 60,000 reprints of articles. The highlight is Stevenson's collection of rare books on the subject of mycology. Many of the volumes date back to the 1700's, and one was published in 1675, enough to make the Stevenson Reference Room the envy of any rare book collector.—C.L. ■

Drying Cotton With Waste Heat



Georgia cotton gin facility. Relocating air intake vents from ground level to near the top of buildings can save money by reusing waste heat. (Photo by Grant Heilman Photography)

Cotton gin managers can save money by reusing waste heat to help dry cotton.

All the managers have to do is relocate air intake vents from the ground level to near the top of buildings where a large pool of hot air collects, according to Agricultural Research Service engineer J. Weldon Laird.

"This simple and inexpensive change will save 15 percent of the overall cost of drying cotton or as much as 75 percent of the cost of second-stage drying. Cotton is dried in two stages, and the second stage sometimes uses cooler air than does the first, which accounts for the greater savings," Laird explains.

This idea came to Laird when he surveyed several cotton gins in Texas to see if the metal gin buildings might serve as solar heat collectors. "Actually," Laird says, he found "the amount of solar heat collected in these buildings is small compared with the amount needed to dry cotton. But a lot of heat builds up from losses from the drying system itself and from motor cooling. Recovering this wasted heat is where the real savings are."

The scientist found that relocating the vents produced additional benefits. It made for cooler, more comfortable conditions for workers. Also, it reduced clogging of intake screens because lint and dust blow about near the floor and do not usually rise to the upper levels of the relocated vents.

Laird did not rearrange machinery in the cotton gin where he performed his experiment. "Better building design and machinery placement would produce more energy savings than we got in our test. Waste heat recovery should be considered in new gin designs," he says.—By **Bennett Carriere,** ARS.

J. Weldon Laird is in USDA-ARS Cotton Production and Engineering Research, Texas A&M University, Route 3, Lubbock, TX 79401. ■

Wind Tunnel Checks Spray Drift

How far can a pesticide be sprayed—sprayed accurately, that is—on a windy day?

Farmers need to know to make sure that pesticide sprays from commonly used airblast systems reach the crops they are aimed at. Sometimes a mere breeze can force the jet-propelled pesticides into near right-angle turns that make them miss their target completely.

"A lot of pesticide chemicals are wasted during spraying operations because of wind," says Robert D. Fox, an Agricultural Research Service engineer in Wooster, OH, who has been studying computer simulations of windblown pesticide sprays as well as watching the real thing in wind tunnel experiments.

"By learning exactly how pesticides get diverted by the wind," he says, "we should be able to develop wind-resistant spraying mechanisms and procedures that could reduce pesticide costs by 30 percent."

Can't farmers simply skip spraying operations on a windy day?

"It doesn't take a strong wind to wreak havoc with a pesticide spray," says Fox.

"Even a mild breeze, at certain angles, can radically alter the direction of conventional airblast sprays," he says.

Fox is particularly concerned about pesticides sprayed from airblast sprayers mounted on tractors or other machines that move through orchards. To reach the tops of the trees, the pesticide has to be sprayed in a high arc that is easily disrupted by the wind.

"We've found that a 15-mi/h crosswind can bend a 120-mi/h spray from that type of equipment as much as 80 degrees," he says. "In fact, with winds from certain directions, the spray can be forced backwards before it gets 6 feet from the nozzle."

Fox and coworkers at the Ohio Agricultural Research and Development Center in Wooster built a 1/12th-size model of a sprayer used in nearby orchards and placed it inside a wind tunnel to measure how

TECHNOLOGY

Porkers' Hides Underused for Leather

Making a silk purse out of a sow's ear may be impossible, but a pig's skin can be made into high-quality leather using a method developed by Agricultural Research Service scientists.

William J. Hopkins, a leather chemist with the agency, says simple, inexpensive processes recently developed at the Animal Biomaterials Research Unit in Philadelphia preserve hides in a nearly fresh state for up to 2 weeks until they can be made into leather. They treat pigskins with acid sulfite solutions or sulfur dioxide. The most common way of treating pigskins is with a salt solution, but there are disadvantages to that method.

Salting down, or brining, shrinks pigskins more than other kinds of hides and reduces the quality of the leather that can be made from them.

But the processes developed by Hopkins lessen hide shrinkage and reduce pollution from salt solutions.

Pigskin makes good leather, according to the Pigskin Council of America, which says it is soft but strong, stretches less than cowhide, and easily takes colorful dyes.

Despite the virtues of pigskin, the council estimates that only about 6 percent—fewer than 5 million—of the 80 million hogs slaughtered each year in the United States are skinned for possible leathermaking.

Most of the pigskins are used in food or converted to fat or protein for industrial and agricultural uses, according to Stephen H. Feairheller, who leads the Unit.

Mindful of the failure to capitalize on an abundant hog industry product, agency scientists are seeking ways to make pigskin processing more economically attractive to the industry.

For example, Hopkins wants to develop a stable air-dried hide product that would offer tanneries yet another alternative to salting pigskins. Other researchers have looked at ways to remove excess fat from pigskins so they can be more easily made into leather.

Hopkins is not neglecting the mainstay of the hide industry, either. He has patented a salt-free way to preserve cattlehides. (See *Agricultural Research,* Jan. 1986, p.16.)—By **Sean Adams** and **Linda Anzelmo,** ARS.

Chemist William Hopkins with treated pigskins. (0186X046-3)

William A. Hopkins is at the USDA-ARS Eastern Regional Research Center, 600 Mermaid Lane, Philadelphia, PA 19118. ■

---

various crosswinds and forward travel speeds affect sprays once they leave the nozzle.

"We have to remember that significant wind problems can arise from movement of the spraying machinery," Fox says as he points to test data which show that an orchard sprayer driven at more than 10 mi/h could lose most of its pesticide to air currents created by the travel of the sprayer itself.

"One solution is to have a sprayer system with nozzles attached to lifting mechanisms that can rise to treetop levels," he says, adding that a prototype of such a system has already been built by ARS engineers.

The wind tunnel tests conducted by Fox enabled him to check and refine a computer program previously developed to simulate how wind affects pesticide sprays.

"For the most part, the computer simulations and our wind tunnel measurements matched up pretty well," says Fox. "At the higher wind velocities, however, the computer tended to underestimate how far the pesticide spray would actually shift. We've now modified the program accordingly."

Fox also used wind tunnel measurements to refine numerical values in the computer program that were based on the flow of air over certain airplane wing designs.

"The arc formed by a high-angle pesticide spray is a lot like a swept-back airplane wing," Fox explains, "and it has some of the same aerodynamic characteristics. Before the wind tunnel tests, aeronautical engineering figures were all we had—but they weren't that far off."

But the wind tunnel data did make the computer program more accurate, says Fox, and that makes it a more reliable engineering tool in the future.

"We can use it with greater confidence," he says, "when designing new pesticide equipment to meet the challenge of a windy day."—By **Steve Miller and Betty Solomon,** ARS.

Robert D. Fox is in USDA-ARS Applied Technology Research at the Ohio Agricultural Research and Development Center, Wooster, OH 44691. ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

More Effective Lure for Corn Borer Traps

A new insect sex pheromone has been developed to help control the southwestern corn borer (SWCB), a major pest of corn in the southwestern and southeastern United States and Mexico.

The sex attractant pheromone consists of three components which occur naturally in the female SWCB moth. Traps baited with the synthetic pheromone have been shown to lure the male insects as effectively as, and sometimes even more effectively than, traps baited with live females.

Trapping, which is often used in areas where infestations of the insects are known to occur, aids in early detection of the moths and alerts extension specialists, crop consultants, and growers to intensify their sampling for borer egg masses and young larvae within their cornfields.

Before development of the pheromone, the presence of the adults was determined by use of blacklight traps, which require a source of electricity for operation and attract a wide variety of unwanted insects. Moreover, the collections are often damaged by excessive numbers of captured beetles. Thus, the pheromone baited traps are much more effective than blacklight traps.

The synthetic pheromone can also be used to suppress SWCB moth populations by interfering with mating communications and by attracting them to a lethal dose of an insecticide.

For technical information, contact Paul A. Hedin or Frank M. Davis, USDA-ARS Crop Science Research Laboratory, P.O. Box 5367, Mississippi State, MS 39762. *Patent Application Serial No. 785,639, "Sex Pheromone Composition for Southwestern Corn Borer."* ■

Artificial Pheromones

The pheromone for the spined soldier bug referred to in "New Chemical Bait Lures Yellowjackets Into Traps," page 11, is Patent Application Serial No. 681,394, *"Synthetic Pheromones for the Spined Soldier Bug,* Podisus maculiventris." See also Oct. 1984, p. 11. ■

Improved Seed Planter

The punch planter, a device used to plant seeds without excessively disturbing the soil, now has a variable rate seeding feature that may make its use more widespread.

In punch planting, uniformly spaced plungers around a wheel penetrate the soil surface. Until now, the inability to change seeding rates limited its use to a few crops or planting situations.

But the new invention replaces the conventional punch wheel with a crank wheel and a pivoting punch column. By adjusting the pivot points of the column and the gear ratio between the crank wheel and a timing wheel the seeding rate can be varied.

The punch planter can be instrumental in reducing soil erosion, because it plants seeds without disturbing residue on the soil surface, which forms a protective cover against wind and rain.

For technical information, contact Maurice R. Gebhardt, USDA-ARS, Building T-12, University of Missouri, Columbia, MO 65211. *Patent Application Serial No. 759,385, "Punch Planter for Variable Seed Spacing."* ■

How To Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

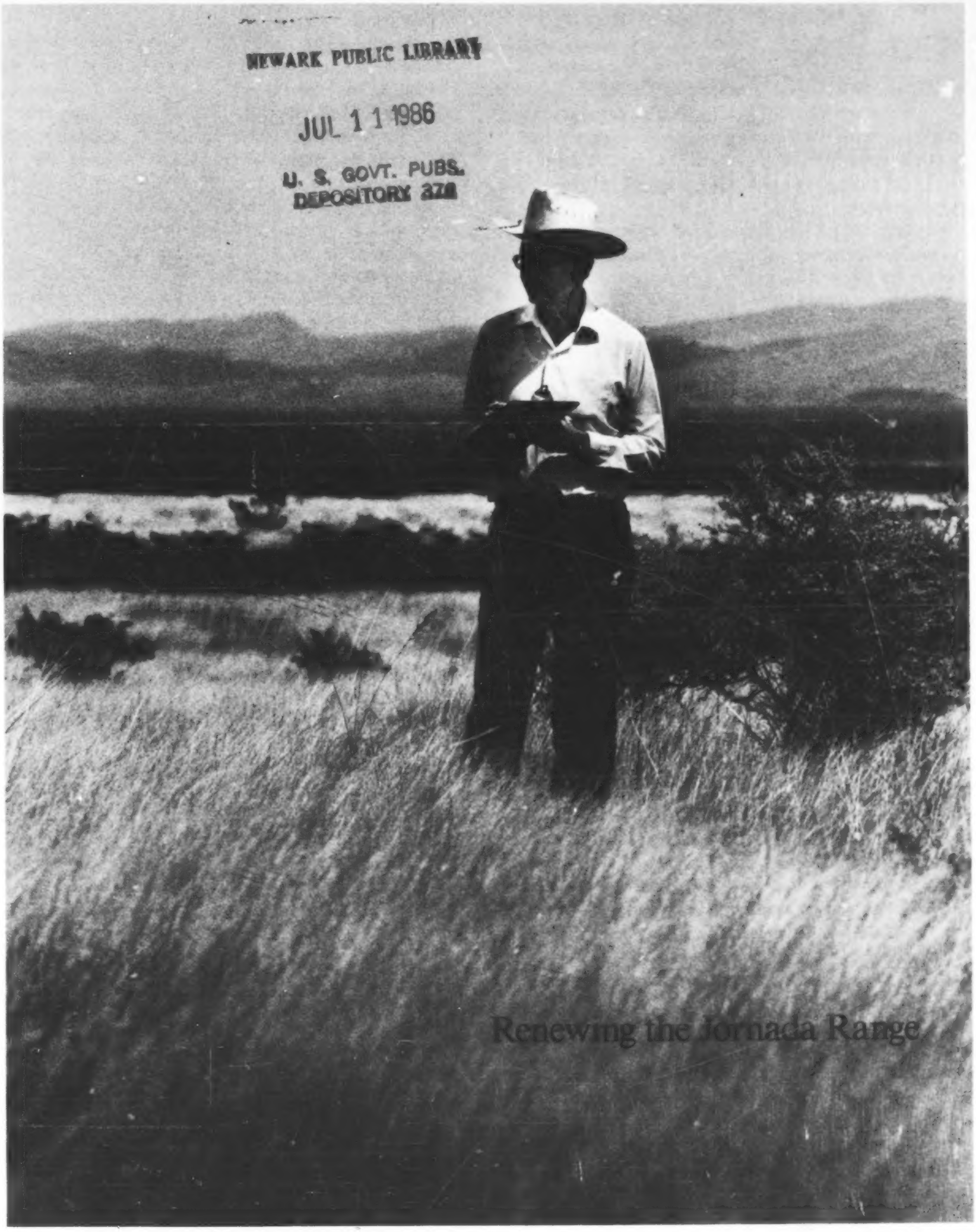
☆ US Government Printing Office: 1986-490-931/40000

34/6

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 6, June/July 1986

Agricultural Research

NEWARK PUBLIC LIBRARY
JUL 1 1 1986
U. S. GOVT. PUBS.
DEPOSITORY 370



Renewing the Jornada Range

A77.12:

FORUM

What Will Bring The Grass Back?

More than 400 million acres of rangeland are in fair to poor condition today, caused by ill-timed or excessive grazing in the late 1800's and early 1900's. In those days of ranching in the southwestern states, for example, one cow could live a year on grass produced by about 60 acres. Now it takes from 200 to as many as 600 in the hardest hit areas.

The long-term effect on the harsh ecology of the western grasslands was not recognized for many years. Ranchers for a time believed the grass would recover with the next good rain and all would be well. But this proved to be false. Grass that had been grazed too much at the wrong time couldn't produce enough nutrients to survive. As the grass weakened and died, brush and other undesirable plants replaced it. The deterioration peaked around 1889, after a 2-year drought that killed many acres of already weakened grasslands.

By the turn of the century, people began to ask the questions they should have asked long before. How do we increase herds without damaging forage plants? How do we manage herds to cope with droughts? How do we restore depleted range—or can we?

In 1904, E.O. Wooton, a farsighted botanist with the U.S. Department of Agriculture, began the first scientific search for answers, on rangeland in southern New Mexico. Largely through his efforts, public land was set aside in 1912 for USDA to administer as the Jornada Experimental Range.

The area that is now the Jornada began as a textbook example of good rangeland gone wrong, an example applicable in principle to all rangeland. Its most important—and sobering—lesson since its inception comes from the fact that it took almost 60 years of careful management to bring a part of the Jornada back to a high-quality condition. Of course, restoration could have been done in less time, but that would have required expensive treatments which from a rancher's standpoint would be impractical.

The science of rangeland management has its roots in places like the Jornada and in the general concern that led to its formation.

USDA has taken a leading role in shaping rangeland science's relatively brief history. The science of range management didn't really get into full swing until about 50 years ago. Looking forward to the next 50 years, the Department faces the continuing challenge of preserving the land and its ecosystems while working to maintain a productive resource on the nation's nearly 1 billion acres of grazing land.

Mindful of the time that it took to restore the Jornada, ARS will place a strong emphasis on long-term, basic research. This research will develop new understanding of how plants and animals interact in rangeland situations that vary from the desert grasslands of the southwest to the bunchgrass steppes of the Palouse in the Pacific Northwest.

From this understanding will come new solutions to problems that continue to plague ranchers:

- Development of computer models such as SPUR (Simulation of Production and Utilization of Rangeland) that can predict the consequences of grazing, weather, wildlife, and many other variables on the range environment.
- Introduction of grasses that produce more livestock feed and are better able to compete with less desirable plants. Kleingrass from Africa produces up to 50 percent more feed in the arid southwest.
- Continuation of traditional breeding programs for forage plants that are more nutritious and higher yielding. Several traditionally bred forage grasses have been released in recent years.
- Genetic alteration of grasses to create varieties not possible with traditional breeding. Johnstone Tall Fescue is a recent success, combining the superior digestibility of ryegrass with the hardiness of fescue. Another creation is Hycrest, a crested wheatgrass and quackgrass hybrid that is drought-resistant and has a 25-percent higher yield.
- Biological control of undesirable weed species, probably the most affordable way to reclaim vast expanses of western rangeland. The philosophy behind this research is to weaken weeds with a group of insects and parasites that together attack several parts of the weed, from seeds to roots to leaves and stems. Although most successes are limited to the laboratory so far, scientists are searching for insects, fungi, and nematodes to control leafy spurge, yellow star thistle, knapweeds, and other weeds.

This approach to biological control research, like the overall range and pasture research program it is part of, is based on understanding the fundamental ecological processes. After all, the most economically efficient way to restore rangeland is to use the dynamic processes of its ecosystems to balance grazing livestock, native grazers, and the environment. Such ecosystems will be able to function self-sufficiently, without the added expenses of pesticides, fertilizers, or annual reseeding.

Gary R. Evans, ARS National Program Leader for Range and Pasture.

Agricultural Research

Cover: Range scientist Carlton Herbel inspects Lehmann lovegrass on the 190,000-acre Jornada Experimental Range in New Mexico where ARS researchers are removing invading brush and shrubs and replacing them with native and introduced forage grasses. Story begins on page 6. (0586X588-28)

p. 7

p. 10

p. 14

6 Jornada Experimental Range: We're Still Learning

Successful livestock production depends on blending economics and ecology in southwestern states.

10 Battle Plans for National Assault on Aphids

Operation C-7 forces are poised for action against a prolific pest.

12 Mold-Eating Mold Might Save Corn

A chance discovery pits one mold against another to benefit farmers.

DEPARTMENTS

4 AgNotes
Milk for the Mature Majority
Purplestraw Wheat Makes a Half Million
Weight-Control Enzyme
Natural Control of Pecan Pest

14 Technology
The Light Way To Measure Body Fat
New Vitamin C Test More Accurate
Breathalyzer for Alcoholic Peanuts

16 Patents
Natural Lure for Grapevine Pest
Laundering Soiled Plants

Vol. 34, No. 6
June/July 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Taylor

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

Milk for the Mature Majority

The majority of the world's people avoid the best dietary source of calcium, vitamin D, and high-quality protein because a glass of milk can bring on stomach cramps, diarrhea, and other problems.

By the age of 20, more than half of the people worldwide stop producing enough of the enzyme needed to digest lactose, the primary sugar in milk, says Agricultural Research Service food technologist Frank E. McDonough at the Beltsville Human Nutrition Research Center.

But McDonough has developed a method that allows lactose-intolerant people to have their milk and digest it too. His study shows that these people can avoid the discomforts associated with ordinary milk by eating yogurt—a fermented milk product—or by drinking sweet acidophilus milk prepared in a special way.

Both products, he says, contain bacteria that produce the missing enzyme, lactase. During the fermentation of yogurt, the bacteria digest a portion of the lactose sugar for their own use. Then, when the yogurt is eaten, these bacteria are digested in the gut, releasing enough of the enzyme to split the remaining lactose molecules into absorbable pieces.

All 14 lactose-intolerant people who participated in the study showed a marked improvement in digestion of yogurt over plain milk, he says.

Commercial sweet acidophilus milk, on the other hand, is prepared by adding bacteria to cold milk, and no fermentation takes place. When the product is consumed, the bacteria remain intact, keeping the enzyme locked up, he says.

To solve this problem, McDonough uses high-frequency sound waves to rupture *Lactobacillus acidophilus* bacteria before adding them to the cold milk. The result: five of the seven lactose-intolerant people who consumed the specially prepared milk digested it easily.

"They could drink at least one cup of the milk per meal, two to three times a day, without any problem," he says.

McDonough is investigating the feasibility of patenting the sound-wave treatment for USDA.—By **Judy McBride,** ARS.

Frank E. McDonough is at the USDA-ARS Energy and Protein Nutrition Laboratory, Rm. 205, Bldg. 157, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■

Purplestraw Wheat Makes a Half Million

A major milestone in managing the nation's plant gene resources has been reached with the entry of the 500,000th plant introduction into the National Plant Germplasm System.

The national system is a cooperative program among private, state, federal, and international agencies to maintain information on live plant materials in the United States. It contains descriptions of the genetic characteristics, country of origin, storage location, plus other information.

Plant introduction numbers date back 88 years to a cabbage variety brought in from Russia, says Agricultural Research Service Plant Introduction Officer George A. White. The milestone PI is a purplestraw wheat which has served as valuable parent material for several other wheat varieties as well as being commercially grown in the Southeast.

"Each plant introduction represents a different source of genetic diversity," says White. With the information contained in the computer database of the National Plant Germplasm System, it is easy for research scientists to locate combinations of plant genes that may lead to crops that can better cope with diseases and insect pests, harsh climates, or poor soils.

Plants and seeds to be entered into the national germplasm program are sent to the ARS Germplasm Introduction and Evaluation Laboratory at Beltsville, MD—the first stop in the network of 45 locations responsible for evaluating, documenting, maintaining, and distributing plant germplasm.

The Plant Introduction Office acts as a focal point, working closely with private, state, federal, and international agencies, to exchange germplasm throughout the world. In 1985, over 95,000 items of plant material were sent to 123 countries.—By **Deborah Aksler,** ARS.

George A. White is in the USDA-ARS Plant Introduction Office, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■

Weight-Control Enzyme

Could pigs, the archetypical heavyweights, one day help free people from obesity? Perhaps. New ways to predict obesity in pigs may lead to slimmer people as well as leaner pigs, according to Gary J. Hausman, an animal physiologist with the Agricultural Research Service in Athens, GA.

Hausman and ARS animal physiologist Dennis R. Campion—working with Roy J. Martin, professor of Human Foods and Nutrition at the University of Georgia—made a discovery when they compared blood and tissue samples from fetuses of genetically fat and lean pigs: All the fetuses of the fat pigs had lower levels of a swine growth hormone coupled with higher amounts of a key enzyme in their blood.

Scientists knew this was true of adult pigs but had not known it to be so for fetuses.

The enzyme lipoprotein lipase (LPL) acts as a gatekeeper, waiting on the wall of blood vessels to break down large fat molecules, allowing the fatty acids to pass through the wall into fat cells. The more LPL available, the more fat deposited in the body.

The swine growth hormone frees fat from storage, letting it be used to build muscle or other tissue. Depressed levels of the hormone mean more fat is stored, making for fatter pigs.

Knowing that the hormone and enzyme levels genetically associated with obesity can be found in the fetus means that genetic fatness in adult pigs can be predicted.

Perhaps the most immediate benefit of this research will be diagnostic tools to select genetically lean pigs for breeding.

But Hausman believes that it may be possible to extrapolate these results to people. As research models, pigs are closer to people than most other laboratory animals. The similarity of the digestive, nervous, and immune systems has been a boon to researchers studying human diseases. Obese people are known to have excessive LPL of a type that closely resembles that of pigs. The swine growth hormone indicator of fatness may also have a counterpart in people.

If so, a simple blood test of infants would allow doctors to tell if children are predisposed to being fat. Parents could then work with nutritionists to plan special diets for their children.

Even more important, this research could be a first step toward food supplements that counteract the genetic tendency to obesity in people and pigs.

Along those lines, Hausman and his colleagues are testing the effects of hormones and other substances on the development of fat cells in laboratory cultures.—By **Don Comis** and **Vince Mazzola,** ARS.

Gary J. Hausman is at the USDA-ARS Animal Physiology Research Laboratory, Richard B. Russell Research Center, Athens, GA 30613. ■

Natural Control of Pecan Pest

Field tests in Georgia pecan groves have demonstrated that partly substituting natural pest control for pesticides could create considerable savings for U.S. pecan growers.

Georgia produced nearly half of the $160 million U.S. pecan crop last year.

W. Louis Tedders, an Agricultural Research Service entomologist at Byron, GA, successfully used both lacewings and ladybugs against pecan aphids and mites in several years of tests.

For ladybugs, Tedders uses the convergent lady beetle *(Hippodamia convergens)*. It readily feeds on pecan pests even in 70- to 100-foot-high trees. [*For more on biological control, see "Battle Plans for National Assault on Aphids," page 10*—**Ed.**]

To encourage proliferation of lacewings and ladybugs, Tedders had a cooperating pecan grower plant vetch and arrowleaf clover among the trees in his 1,700 acres of orchard. Lacewings and ladybugs eat pea aphids, and pea aphids thrive on vetch and clover. The predators flourished and saved thousands of dollars in pesticide costs during the first half of the 1985 growing season. The appearance of other pest species midway through the season prompted the grower to apply pesticides. Tedders persuaded him to leave 30 acres alone, for comparison.

Interestingly, Tedders found that insect damage in the unsprayed 30 acres was no worse than that in the sprayed area. "He would have been better off not spraying at all that season," Tedders says.

However, because the ladybugs and lacewings are themselves subject to predation and disease, it is not likely that growers could maintain high enough populations year after year to ensure adequate protection of the crop without pesticides.

Near Albany, GA, cooperating farm manager Buddy Reese examines pecan trees for pecan aphids and the lady beetle *H. convergens.* (0586X595-21A)

Tedders is looking at a rotation plan that would combine both natural controls and pesticides. He will be determining if it is possible to use beneficial insects up to the point when natural factors reduce their numbers. Then pesticides would be used, either to control the predators, parasites, and diseases of the beneficial insects or to directly control the pecan pests. Such a rotation might involve spraying only every other season.—By **Linda Anzelmo** and **Don Comis,** ARS.

W. Louis Tedders is at the USDA-ARS Southeastern Fruit and Tree Nut Research Laboratory, P.O. Box 87, Byron, GA 31008. ■

Jornada Experimental Range:

Fifty years ago, much of the rangeland of the Southwest, including the Jornada, had been taken over by brush. Because of economic and social changes, this labor-intensive method of clearing brush for replanting to grass is no longer feasible. (333012 RM-Research; photo courtesy National Agricultural Library, Forest Service Collection)

With little-known names like black gramma and mesa dropseed, their passing would not be noticed by many people. But as these grasses and others lose in the perennial battle for growing space on southwestern ranges, so do ranchers whose cattle and sheep depend on them for food.

Early ranching and farming practices, and normal droughts inflicted by nature, changed many grasslands to brushlands in Arizona, New Mexico, and Texas. Woody plants, once restricted mainly to waterways and natural drainage areas, now form an almost continuous cover over millions of acres of former grasslands.

Invasion by these poor-quality plants drastically cuts the number of grazing animals an area can support.

The range condition of many areas in the arid Southwest is so low today that each cow needs grass from 200 to 600 acres of rangeland to survive for a year. Late in the past century, some ranchers were using only 60 acres per cow per year.

"The introduction of cattle to the area in the 1880's contributed to the vegetative change from grasslands to shrublands. Overgrazing, coupled with periodic droughts, slowly changed ranges totaling perhaps 100 million acres," says Agricultural Research Service range scientist Carlton H. Herbel, Las Cruces, NM.

When grasses are grazed too close to the ground, it is easier for drought to kill them. Proper grazing—carefully matching the correct number of cattle to the amount of forage—reduces this hazard.

Another factor contributing to the spread of brush is cattle swallowing whole seeds. These seeds can pass through their bodies without being affected by digestive juices. When animals, including wild species, defecate, brush seeds are dispersed on land that was brush-free. These seeds are in an ideal growing medium—the manure provides them both moisture and nutrients.

Farmers contributed to this decline by plowing under native grasses so they could plant small grains such as oats and wheat. These new crops survived when the rains came, but droughts eventually drove the farmers out of business.

Seeding to restore these ranges is difficult and often uneconomical. Native grasses, and many of those brought from foreign countries, just don't produce seed that is equipped to sprout efficiently and grow on the area's limited rainfall. Woody plants now cover these abandoned fields.

In the 1930's, the Civilian Conservation Corps enclosed about 2,000 acres of New Mexico rangeland with a fence that would keep out all grazing animals, including wildlife. The area, located on the 190,000-acre Jornada Experimental Range near Las Cruces, NM, still shows a surprising change from grass to brush, thus demonstrating

We're Still Learning

"Bonded" sheep and beef cattle on the Jornada Experimental Range. Cloth tape encircling the animals' bodies show their bonding groups for long-distance identification. (0586X574-13)

the ability of brush to continue to invade damaged grasslands even without livestock grazing.

Some people had thought the ranges would recover on their own.

"We can trace vegetative changes on the Jornada because surveyors for the U.S. government carefully recorded types and densities of plants when they crossed this area in 1858. Range scientists have made periodic inventories since then," says Herbel.

The inventories paint a graphic picture of brush replacing grass. Of the 144,475 acres surveyed in 1858, 90 percent were covered with grass. By 1915, dense brush—mainly mesquite—had invaded a quarter of the land. By 1963, only a quarter of the land still had good grass cover and almost none remained brushfree.

Carefully regulating the number of animals is necessary to prevent further degradation. Calculating the proper number of cattle for each range is still pretty difficult. Ranchers can't predict the amount of precipitation their land will receive in the future. This makes it difficult to plan herd size and marketing strategy.

> ***"With social bonding and specially trained guard dogs, we may be able to protect our sheep without building expensive fences."***
>
> —**Clarence V. Hulet.**

"We can improve these ranges, but it won't be cheap or easy," says Herbel, who works at the Jornada. "And it may require decades to make any real progress."

To improve them, it is necessary to chemically or physically remove the woody plants and replace them with more nutritious grasses, says Herbel.

He and fellow ARS scientists on the Jornada have developed techniques to reduce brush and shrubs and make way for native and introduced grass species.

One way is to ride horseback, applying herbicides to individual plants. In badly infested areas, hiring commercial aerial applicators to spray may be more practical.

Social Behavior on the Range

Sheep and cattle normally segregate when grazing the same range. The sheep stay together at one end of the range while the cattle eat at the other. Later, they change territories, each eating its favorite kind of forage.

However, by bringing the two animal species together when the lambs are very young, it is possible to form a close social bond in which lambs develop an impelling need to be close to

Tissue culture of four-wing saltbush, a range plant native to much of the western United States, is examined by geneticist Jerry Barrow. Lab cloning may lead to faster development of stress-tolerant plant varieties that are suited to livestock forage and forage and cover for wildlife. (0586X569-19)

cattle as they move about on the open range.

Scientists at the Jornada Experimental Range hope that this kind of bonding will cut lamb losses from predators. Cattle intensely dislike coyotes and strange dogs, and it is reasoned that if cattle and sheep mingle while grazing, the cattle might butt or kick at these predators to drive them away.

"With social bonding, plus specially trained guard dogs that attack predators, we may be able to protect our sheep without building expensive fences," says animal physiologist Clarence V. Hulet.

Currently, electrified, multistrand fencing is required to keep sheep safe. Losses before the fence was installed were catastrophic. Hulet says, "Because sheep are so meek, coyotes and wild dogs find them easy marks on our ranges. We lost 44 percent of our sheep to coyotes the first year we had them on the Jornada Range."

Electric fences and guard dogs have cut losses to about 5 percent. But Hulet hopes that if cattle and sheep stay together while grazing, even fewer sheep will be killed and costly electric fencing can be eliminated.

In studies so far, animal scientist Dean M. Anderson has found the strongest bonding during grazing resulted from an initial penning of 45-day-old lambs with yearling heifers for 30 days. The two livestock species are now freely intermingling as they graze pastures on the Jornada Experimental Range.

Protection for sheep is not the only benefit from intermingling livestock, Anderson says. Cattle eat mainly grasses while sheep prefer leaves from some small shrubs and broadleaf plants such as deer's tongue and woolly paperflower. In general, the more variety of plants on a range, the greater the potential for increased production through multispecies grazing.

In the experimental pastures, the scientists added two sheep for every cow. This heavier stocking rate does not seem to be damaging the range.

Coexistence is nothing new in the animal kingdom. For millions of years, various animals shared feed in the same area. This type of grazing still exists today on the natural grassland ecosystem of the Serengeti Plain in the east African nations of Tanzania and Kenya. The ARS scientists are examining ways to extend this to modern, more efficient meat and wool production.

Plants "Hibernate" During Drought

Some range plants struggling to survive drought cope with the situation much as bears do with winter—they "hibernate."

The plants' respiration slows, they give off less carbon dioxide, shed small roots, and live off stored carbon and nitrogen.

Agricultural Research Service plant physiologist William B. Sisson says

The Jornada Experimental Range

In 1912, some 190,000 acres of semidesert rangeland was withdrawn from public lands to form the Jornada Experimental Range in southern New Mexico. Sprawling between the San Andres Mountains to the east and the Rio Grande Valley to the west, this research ranch is one-fourth as large as the state of Rhode Island.

Its name—a Spanish word meaning an arduous journey—arises from its arid climate. Since the Jornada was established 74 years ago, it has seen several severe droughts. The most recent, in 1951-57, is believed to be the worst in 350 years.

The Jornada is subdivided into 44 experimental pastures by 307 miles of 4-wire fence. The vegetation, soils, and climate are similar to those for some 90 million acres in the Southwest. While 1 acre of good pasture in the Midwest or South may grow enough forage to feed one cow all summer, the average acre on the Jornada only provides enough forage to feed one cow for 1 to 3 days.—**D.S.** ■

that plants, like bears, face disaster if conditions are too harsh or prolonged. They run out of stored nutrients and die.

Sisson is conducting fundamental research to discover why some plants are better equipped to survive prolonged droughts. He has developed ways to track how efficiently range plants absorb essential elements such as carbon and nitrogen during good times and ration them during bad.

He is now using these findings to evaluate range plants from other parts of the world that might be suited to the southwestern United States. Researchers at the Jornada Experimental Range have tested several hardy, new grasses that outproduce native grasses. One of these, Lehmann lovegrass from Africa, yields twice as much forage as native grasses.

Kleingrass, also from Africa, seems well adapted to the area and may be a candidate to replace native grasses lost during droughts. Sisson says Kleingrass continued to extract nitrogen from the soil even during a a 60-day drought. This range plant is now thriving in parts of Texas and at the Jornada.

"We hope to learn what it takes to make plants successful survivors in desert areas," Sisson says. "When we learn more, plant breeders and perhaps genetic engineers will be able to use this information to develop new varieties." These would not only be survivors, but would provide more palatable, nutritious feed for grazing livestock and wildlife and hold soil from wind and water erosion.—By **Dennis Senft, ARS.**

Scientists mentioned in this article are in USDA-ARS Range Management Research, New Mexico State University, P.O. Box 3JER, Las Cruces, NM 88003. ■

In his greenhouse, physiologist William Sisson studies water-use efficiency of Kleingrass and other range plants to determine their adaptability to the Southwest where the annual rainfall is 10 inches or less. (0586X585-8)

Battle Plans for National Assault on Aphids

Hunting on an alfalfa leaf, a sevenspotted lady beetle captures one of its favorite dinners – a pea aphid. (0678X780-17)

The U.S. Department of Agriculture is planning a national assault on crop-destroying aphids. Their soldiers—an army of hungry ladybugs.

These hardy European and Asian predators, sevenspotted lady beetles *(Coccinella septempunctata)*, are bigger cousins of American ladybugs. The operation is known by an abbreviated version of the beetle's name: C-7.

The battlegrounds will be mainly the fields and gardens of the West, since the beetles already have a good start in the East. The leadership for the battle goes to USDA's Animal and Plant Health Inspection Service, the agency charged with coordinating biological control of agricultural pests.

Aphids are small, soft-bodied pests that suck sap from host plants, killing them or stunting their growth. They attack a variety of crops, including wheat, rice, corn, beans, alfalfa, barley, oats, peas, potatoes, sugarbeets, fruits, and vegetables. Citrus groves to Easter lilies have been laid to waste from their feeding and the plant diseases they carry.

If conditions are right, aphid numbers can swiftly rise to unmanageable levels—theoretically, as many as 600 billion in 9 generations.

But the sevenspotted lady beetle is a biological match for aphids, according to Richard J. Dysart, an entomologist with the Agricultural Research Service's Beneficial Insects Research Laboratory in Newark, DE. "A single larva can eat 300 to 600 aphids before pupating into an adult. And a single adult can put away from 2,000 to 3,000 during its lifetime."

And when aphid numbers get low, this predator is versatile enough to switch to eating plant pollen and nectar, enabling it to stay on the scene, ready to do battle again.

Dysart says, "Because the beetle can adapt to a variety of crops in diverse environments in Europe, we hope it will thrive throughout much of the United States."

The adult is about three-eighths of an inch long, making it larger than most of the 475 species of American ladybugs. Easily recognizable, it has deep reddish wing covers that carry the seven black spots that give it its name. Its head region is black, except for a small amount of white behind each eye.

In the spring, hungry adults move from their winter sites—tucked away in clumps of grass—and start clearing aphids from crops. After gorging themselves, adult females begin laying yellow eggs in clusters of 10 to 30, glued to the underside of leaves or other vegetation. Eggs take 3 to 5 days to hatch into larvae in the southern states, longer in colder parts of the country.

One of the earliest biological control successes was in 1888, when U.S. Department of Agriculture researchers began shipping vedalia beetles to California and releasing them in citrus orchards. These pioneers saved the

APHIS insect production coordinator Mike Bryan (left), APHIS Plant Protection and Quarantine Officer Gerry Terensinski (right foreground), and ARS entomologist W. Louis Tedders mount nets on a truck for a sweep through fields of legumes to collect sevenspotted lady beetles. (0586X598-18A)

Plant residue and sevenspotted lady beetle larvae and adults collected in nets during a truck run through fields. (0586X598-35)

citrus crop from an overwhelming attack of cottony cushion scale insects and have kept the insects under control ever since.

Just as the vedalia controlled scale in its native Australia, the sevenspotted beetle has been valued in Europe and Asia since the late 1880's for its ability to control aphids.

Dysart says the ARS Beneficial Insects Research lab first tried the sevenspotted ladybug in the United States in 1958. The lab either released or provided insects for 111 intentional introductions between 1958 and 1983. However, there was no evidence of permanent colonies before June 1973, when specimens were collected from northern New Jersey. Since then, they have become established in the eastern United States, with significant colonies as far south as Georgia and as far west as Indiana.

The sevenspotted lady beetle has great potential for protecting U.S. crops from the ravages of aphids. In some areas, the ladybugs are exerting significant control over aphids—saving farmers and gardeners millions of dollars a year in production costs. In other known introductions, however, they seemed to thrive for a year or so then disappeared.

It isn't completely clear why new colonies disappeared. Sometimes the introductions were too small, as in the case of a 1958 release in Imperial County, CA, which involved only 25 beetles. In other cases, the releases may not have been well timed. The beetles do better when released in spring than in fall and better when released in the evening than in the morning. Some releases could have fallen victim to insecticides.

Most efforts to spread the beetles will focus on states west of the Mississippi River, where they have so far successfully colonized only one small area in Oklahoma, according to Gary Cunningham, the APHIS plant pest specialist in charge of biological control programs.

The beetles to be released will come from established colonies in the East, such as those at the ARS Southeastern Fruit and Tree Nut Research Laboratory in Byron, GA. One reason APHIS chose the Georgia lab is that the beetles were successfully established there by ARS in 1976 and their numbers have increased each year since.

The agency also chose Byron because there is room to grow large fields of legumes to attract pea aphids, a favorite food of sevenspotted lady beetles. Tom Burger, head of the APHIS Biological Control Laboratory in Niles, MI, and Mike Bryan, the lab's production coordinator, are working with W.L. Tedders at the Georgia lab to determine the best legume varieties for attracting the beetles, on irrigated and nonirrigated land. They have 14 plots on 25 acres at Byron, planted with varieties of crimson clover, hairy vetch, and arrowleaf clover.

Burger and Bryan are also trying to determine the plant varieties most suitable for mass-collecting the beetles with mechanized equipment, such as four-wheel-drive vehicles with large nets attached. That's the way the Niles lab successfully collected alfalfa weevils in another APHIS biological control project. The vehicles will be driven through the legume fields in the hopes of sweeping beetles into the nets in large numbers. If this equipment proves unsuitable to collect lady beetles, other equipment will have to be used, perhaps a sort of large vacuum cleaner.

Tedders says the APHIS legume plots, planted near the end of 1985, have already attracted millions of sevenspotted beetles.

APHIS will release the predators at about 300 sites across the western two-thirds of the country and maybe at some sites in the East where the beetles might not be well established. Plans call for APHIS to release 4,000 of the predators at most sites and up to 20,000 at others.

As a guide on where to release, the agency will use a map of the United States, with grid lines drawn at 120-mile intervals. Releases will be made at many of the points of intersection—provided they are not in Death Valley or some other area not likely to be populated with aphids. They will also be released in areas known to have aphid problems, whether they are at the grid intersections or not. The exact number of sites will depend on the results of a survey.

APHIS plant protection inspectors will make the releases, working cooperatively with people from state departments of agriculture, the Extension Service, ARS, and university researchers. They will notify farmers and gardeners locally before distributing beetles.

"There is a lot of interest in improving and expanding the use of biological pest control to limit damage done by both insects and weeds," Cunningham says. "We are looking into all types of methods—including sterile-male release, pheromones, and diseases and parasites of pests—as alternatives to conventional pesticides."

This year, as part of a continued and expanding interest in biological control, APHIS enlarged the technical advisory group that selects the most promising projects. The group originally had representatives from APHIS, ARS, USDA's Cooperative State Research Service, the Extension Service, the U.S. Environmental Protection Agency, and the National Plant Board (a group of state plant pest specialists). Now the group also includes representatives from state experiment stations, USDA's Forest Service, and regional APHIS offices.

At a meeting earlier this year at the ARS lab in Delaware, the advisers recommended APHIS consider biological control projects against four other pests:

- Rush skeletonweed in the Pacific Northwest with a mite, a midge, and possibly a fungal rust.
- Leafy spurge, a weed found mainly in the northwestern quarter of the United States, using a defoliating moth and possibly other beneficial insects.
- Lygus bug, a pest of cotton and alfalfa, using a variety of parasites.
- European corn borer with an imported parasitic tachinid fly.

The sevenspotted lady beetle project is one of six ongoing APHIS biological control projects started in the past 4 years. The others are concerned with the following pests: alfalfa weevil, citrus whitefly, silverleaf nightshade, Colorado potato beetle, and diffuse and spotted knapweed.—By **Don Comis,** ARS, and **Max Heppner,** APHIS.

Richard J. Dysart is at the USDA-ARS Beneficial Insects Research Laboratory, 501 South Chapel Street, Newark, DE 19713. Gary Cunningham is at the USDA-APHIS Technology Analysis and Development Staff, 648 Federal Building, Hyattsville, MD 20782. ■

Mold-Eating Mold

Even if you could say *Sphaeronaemella helvellae,* it still doesn't sound very friendly. But this mold could wind up saving farmers millions of bushels of corn each year, says plant pathologist Nader G. Vakili.

Vakili, a researcher with the Agricultural Research Service in Ames, IA, happened on *S. helvellae* while he was studying the fungi that make cornstalks rot and fall over before harvest.

In this case, he was surprised to see one fungus growing on another rather than on the stalks. The strange fungus didn't look much different from the others at first, but Vakili could see through the microscope that it had invaded a stalk-rot fungus.

S. helvellae had spread throughout much of the damaging fungus' mycelium—the weblike filaments that grow into the host plant's tissues. The new fungus was even destroying the reproductive spores of its victim.

Vakili had chanced on a mold-eating mold.

Since that day 4 years ago, he has been working to find ways to use *S. helvellae,* and a half dozen other friendly fungi that he has located, to control certain cornstalk diseases.

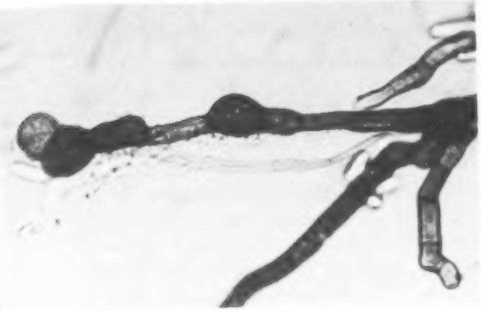
Stalks weakened by molds are a fairly serious problem to corn farmers, says Vakili. His experience with more than 200 commercial corn varieties in 6 years of tests has been that stalk rot losses average 5.6 percent of the crop each year. On this basis, 1985 losses in Iowa—the leading corn-producing state—would have been around 95 million bushels.

Vakili believes that his collection of mold-eating fungi can be used to complement the disease resistance that plant breeders are striving for in commercial corn varieties.

Experiments have shown that some corn lines benefit more than others from treatment with mold-eating fungi, indicating that corn breeders should be able to develop corn lines that provide a favorable environment for the mold-eating fungi.

In one experiment to evaluate the mold-eating molds, Vakili treated seed corn of four corn lines with spores of five friendly fungi: *S. helvellae, Gliocladium roseum, Trichothecium*

Might Save Corn



Microscopy reveals the transparent, shadowy outline of the friendly fungus *Sphaeronaemella helvellae* parasitizing the spore-production structure in the harmful fungus *Helminthosporium carbonum* and preventing spore dispersion. (PN-7212)

roseum, an *Exobasidiellum* sp., and *Gonatobotrys simplex*.

Seeds were placed in a planting medium with several disease fungi: *Penicillium, Fusarium moniliforme* (causes one of the worst corn diseases, according to tests run by ARS plant pathologist Raymond L. Clark at Ames), *Rhizopus* sp., and *Cephalosporium acremonium*.

The germination rate was higher and root growth was greater with the protective spore treatment. Seedling vigor, as measured by weight of the roots, was significantly increased. In the germination tests, 97 percent of the kernels treated with *S. helvellae* germinated, compared with 88 percent of the untreated kernels. When analyzed for disease, kernels treated with *G. roseum* showed 6.6 percent diseased kernels; untreated kernels were 42 percent diseased. *G. roseum* practically eliminated *Penicillium* from all four of the corn lines it was tested on.

In addition to disease control, another advantage of using a fungus to control a fungus is safety, Vakili says. Seed corn is commonly treated with fungicides that are toxic to animals, so unneeded seed corn cannot be used and must be destroyed. If mold-eating fungi were used as a fungicide, unused seed corn could be safely fed to livestock.—By **Ray Pierce,** ARS.

Nader G. Vakili is in USDA-ARS Cereal and Soybean Improvement Research, Rm. 411 Bessey Hall, Iowa State University, Ames, IA 50011. ■

Plant pathologist Nader Vakili observes dual cultures of *S. helvellae* and its host, *H. carbonum*, on agar medium. (108X1276-27A)

The Light Way To Measure Body Fat

Using a computer-assisted near-infrared spectrophotometer, chemist Joan Conway measures body fat content of biological lab technician Janice Collins. (0586X601-28)

A touch of a wand to your biceps can give you a computer printout showing your body fat percentage.

This high-tech fat-measuring technique is being tested at the Human Nutrition Research Center in Beltsville, MD. It uses short wavelengths of harmless, infrared light to measure body fat at key spots on the body, says Joan M. Conway, a chemist at the Center. Conway is collaborating with ARS engineer Karl H. Norris, who invented the infrared interactance (IRI) technology.

IRI makes use of the principle that fat, water, protein, and other body components absorb different parts of the near-infrared spectrum. When near-infrared light is beamed through the skin—one wavelength at a time—each wavelength is either absorbed or reflected depending on the type of tissue it hits.

When further refined, IRI could lead to commercial machines that are portable and easy to use. Conway is also comparing infrared interactance with other methods for measuring body fat.

According to Conway, machines based on IRI "would be ideal for doctors' offices and hospitals to help determine if patients are losing or gaining fat on prescribed diets."

She expects that college athletic departments and professional sports teams would be among the first users.

IRI's results will have to be validated through many more tests with humans under controlled experimental conditions, Conway says, but "it has tremendous potential for simplifying the measurement of body fat."

A portable body-fat machine "would make it easier for researchers to do large-scale surveys on body composition," she says. The results could then be used in conjunction with information about the surveyed population's eating habits to refine calorie requirements. Currently, the most common method for assessing body fat is to pinch the skin and measure its thickness at several spots on the body, but the procedure leaves a lot of room for error.

Tests on 155 men and women ranging in age from 20 to 65 have shown IRI to be faster, easier, and more accurate than using skinfold measurements, Conway says.

IRI estimates of total body fat compared favorably with estimates obtained by the deuterium oxide, underwater weighing, and total body impedance methods. Underwater weighing and deuterium oxide are the current "gold and silver" standards for body composition studies, she says, but both have limitations. They are time-consuming, must be done in a laboratory, and require subjects to give blood samples or to be totally submerged in a water tank.

ARS engineer Norris discovered the principle behind IRI more than 20 years ago and has used it to develop prototypes for a number of commercial instruments. These instruments are now being used in the agricultural industry to assess the fat content of ground meat, the oil content of avocadoes, and the nutrient content of grains and forages. With Norris' help, Conway is trying to adapt the technology to people.

For the human studies, the two scientists borrowed an instrument based on Norris' research from the Neotec Instruments Division of Pacific Scientific. The instrument—a computerized spectrophotometer—was programmed to read the amounts of fat and water, because the two are mutually exclusive. When the fat content increases, the water content decreases proportionately.

To determine total body fat, Conway measures five of the sites on the body used in the skinfold method. The five sites are on the front of the upper arm at the bicep, on the back of the upper arm at the tricep, on the back just below the shoulder blade, above the hip, and on the front of the thigh.

However, Conway says, her results show that the bicep measurement alone may give a good estimate of body fat.

Conway and Norris will soon be testing a simpler instrument that scans only a few selected wavelengths instead of the 400 used in these studies. It would be portable, less expensive to manufacture than the computerized spectrophotometer, and easier to use.

If the team is successful, says Conway, "commercial body-fat machines could even wind up in drug stores and supermarkets like the blood pressure machines you see today."—By **Judy McBride,** ARS.

Joan M. Conway is at the USDA-ARS Beltsville Human Nutrition Research Center, Rm. 318, Bldg. 308, BARC-East, Beltsville, MD 20705. Karl H. Norris is at the USDA-ARS Instrumentation Research Laboratory, Bldg. 002, BARC-West, Beltsville, MD 20705. ■

New Vitamin C Test More Accurate

Vitamin C can be measured in blood more accurately than ever before with a new test developed by Agricultural Research Service scientists.

The test distinguishes vitamin C or ascorbic acid from the closely related compound isoascorbic acid that is used as a food additive, says Stanley T. Omaye, a nutritionist at the agency's Western Human Nutrition Research Center in San Francisco.

"Until now, the most commonly used methods to measure vitamin C didn't distinguish between the two compounds," says Omaye. "This means that results from these earlier tests—which are used by physicians, nutritionists, and other health-care professionals—could be misleading because isoascorbic acid doesn't have the same benefits as vitamin C."

The test can be used to detect vitamin C deficiency and to let doctors know if patients recovering from burns or surgery are getting enough vitamin C. "If the test is routinely used to monitor vitamin C, it can identify small but important fluctuations in a patient's vitamin C level long before an actual deficiency occurs," Omaye says.

According to Omaye, leading candidates for the deficiency in this country include teenagers who go on fad diets or elderly patients who fail to eat enough fruits and vegetables rich in vitamin C.

Vitamin C helps heal wounds and keep teeth, gums, bones, and joints healthy. Good sources are citrus fruits, strawberries, cantaloups, leafy green vegetables, peppers, broccoli, and cauliflower.

Vitamin C and isoascorbic acid can be identified by other tests, but they are much slower and are not as sensitive as the new procedure. These tests also fail to detect very small amounts of the vitamin and require more blood for the sample.

Omaye, along with Mark A. Kutnink, James H. Skala, and Howerde E. Sauberlich at the Center, developed the test. Sauberlich is now at the University of Alabama at Birmingham.

The test uses what may be a unique combination of a superior preservative and another chemical that makes separation of the compounds possible. The preservative is needed because vitamin C is highly unstable and decomposes rapidly, making it difficult to measure accurately.

Omaye says food processors can use the new test to check vitamin C levels in their products against the levels stated on the product labels, or they can use it to check levels of isoascorbic acid.—By **Marcia Wood,** ARS.

Stanley T. Omaye is at the USDA-ARS Western Human Nutrition Research Center, P.O. Box 29997, Presidio of San Francisco, CA 94129. ■

Breathalyzer for Alcoholic Peanuts

A peanut containing too much alcohol can be declared "drunk" by a new test that Agricultural Research Service scientists have developed.

If peanuts are exposed to severe cold or heat before they are cured, they produce alcohol and related compounds that give them a bitter flavor, according to Harold E. Pattee, an ARS chemist in Raleigh, NC.

"It's sort of a breathalyzer test," says Pattee, who developed the testing concept. "The meter tells us the level of alcohol and related compounds so that the bad-tasting nuts can be separated from the good-tasting ones. Those with off-flavor can still be used to make oil and other products."

The meter is being tested in Georgia, Texas, and North Carolina, according to Pattee and James W. Dickens, an ARS agricultural engineer who designed the meter. Georgia is the biggest peanut-producer by far, with Alabama running a distant second and Texas and North Carolina following closely behind. Testing will be expanded in the fall when this year's peanut crop is sold.

If it proves successful, Dickens says, the meter may move into commercial use. "A meter will cost about $500, which is cheaper and more practical than potential chemical tests that are still under development."

In the test, about 3 ounces of peanuts are put in a blender and ground up for 10 seconds. A special sensor is put in a hole at the top of the blender for 4 to 5 seconds. The sensor detects alcohol vapor, just as a smoke detector measures smoke.

Professional taste panels judge peanuts with a meter reading of 360 or more to be unacceptable. At that high a level, the alcohol and related compounds vaporizing from the sample are equal to that coming from a solution of 0.021 percent ethyl alcohol.

The peanuts with the lowest readings registered 231—equivalent to 0.002 percent ethyl alcohol and water.

Alcohol and other related compounds are formed in freshly harvested nuts when they are subjected to freezing temperatures, or when they are heated beyond 95°F. Extreme temperatures upset their respiration, causing them to produce alcohol.

Cold can be a problem after peanuts are dug but before they are harvested. Often farmers dig them and leave them in the fields for 5 to 7 days before picking from the vines, allowing them to partially dry in the fields. But during that period, they can be damaged by frost or freezing, despite a farmer's best efforts to prevent it.

Heat can be a problem when nuts are cured to remove moisture. Peanuts contain from 40 to 50 percent moisture when dug, and field-drying lowers that to about 20 percent. Then they are usually cured to about 8 percent moisture by forcing heated air through them. If the heated air is not carefully controlled, damage occurs.—By **Sean Adams,** ARS.

Harold E. Pattee is in USDA-ARS Market Quality and Handling Research, North Carolina State University, P.O. Box 7625, Raleigh, NC 27695 ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G–95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

Natural Lure for Grapevine Pest

A sex attractant that's given off by a destructive insect of California vineyards—the grapeleaf skeletonizer—has been isolated, synthesized, and patented. The attractant, a pheromone, lures male moths to special vineyard traps used to monitor the size and location of the infestation. This information is used when deciding on pesticide applications. The traps are more economical and faster than the more tedious vineyard inspections for moths.They might someday also be used on a larger scale to reduce the population of skeletonizers if these insects become resistant to currently used insecticides.

Female grapeleaf skeletonizer moths emit the attractant, known as *sec*-butyl *(Z)*-7-tetradecenoate, to lure the bluish-black male moths during mating season. Shortly after mating, the female lays eggs that later develop into voracious, leaf-eating larvae. The wormlike larvae kill the leaves of the grapevines and leave the vine unable to produce chlorophyll. The white, lace-like, skeletal look of the leaves is unmistakable evidence of skeletonizer damage. Hairs on the larvae can sting and leave a welt on the skin of grape pickers or others who come in contact with the insect.

For technical information, contact Edwin L. Soderstrom, USDA-ARS Horticultural Crops Research Laboratory, 2021 S. Peach Avenue, Fresno, CA 93747. *Patent No. 4,563,348, "Sec-butyl (Z)-7-tetradecenoate and Its Use as a Sex Attractant for the Grapeleaf Skeletonizer."* ■

Laundering Soiled Plants

Agronomists studying plant propagation are often faced with the tedious task of separating roots, seeds, and other plant tissue from soil samples. Previous filtering devices could only wash small amounts of soil at a time, were laborious to operate, and did not work effectively with clay soils. Now, a new apparatus has been developed which can rapidly and thoroughly separate plant tissue from soil and accommodate a large volume of material at one time.

The device consists of a wash tank, a rotating offset shaft and drive assembly, canisters to hold the soil samples, and a canister-support cradle. The tank is filled with water, the machine is switched on, and the shaft rotates to submerge each canister and agitate it gently. Perforations in the canisters allow solution and soil to move freely but keep the plant tissue intact.

The new washer could also be used for cleaning archaeological artifacts, precious stones, and other items which are heavily soiled. If necessary, a mild detergent may be added to the wash tank.

For technical information, contact William W. Donald, research agronomist, USDA-ARS Metabolism and Radiation Research Laboratory, P.O. Box 5674, State University Station, Fargo, ND 58105. *Patent Application Serial No. 06/825,004, "Washer for Plant Roots and Other Articles."* ■

How To Obtain a License for USDA Patents

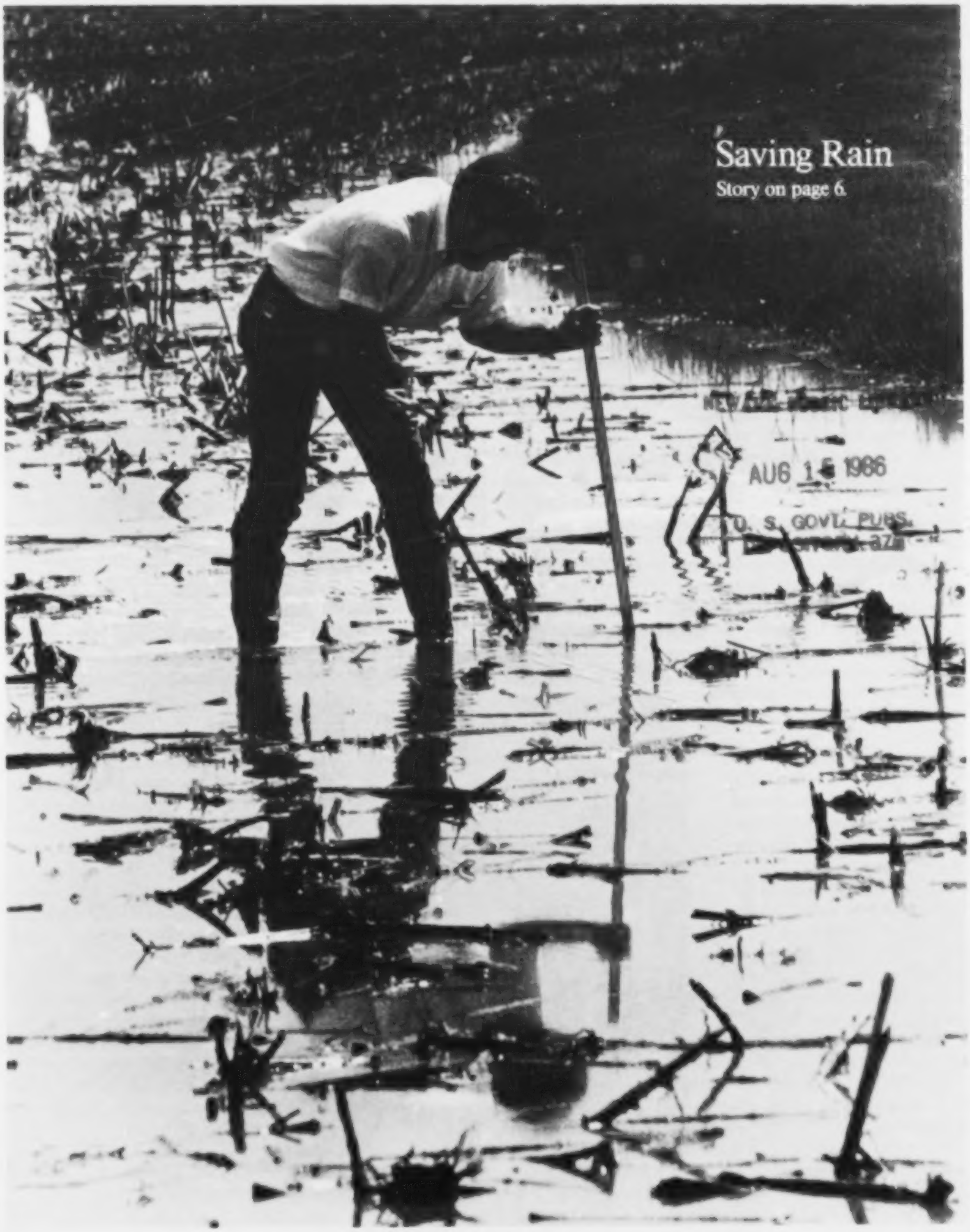
A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

34/7

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 7, August 1986

Agricultural Research



Saving Rain

Story on page 6.

NEWARK PUBLIC LIBRARY
AUG 18 1986
U. S. GOVT. PUBS.

READEX FICHE best copy available

A 77.12:

E.F. Knipling—a Pioneer in Insect Control

When Edward F. Knipling first thought of turning normal insect reproduction into a weapon against the screwworm fly, he was met with more than a little disbelief.

Knipling developed his revolutionary theory, later called the sterility principle, in the 1930's while combating the screwworm fly for USDA's Bureau of Entomology and Plant Quarantine at Menard, TX. At that time, screwworms were a major killer of livestock and wildlife. Flies multiplied unchecked by laying their eggs in open wounds.

Based on his studies of screwworm behavior, Knipling thought infestations of the pest could be eradicated by overwhelming it with laboratory-reared male flies that had been sterilized somehow. The sterile flies would ensure numerous barren matings.

For years, people scoffed at this "crazy" theory. Throughout it all, Knipling maintained confidence in an idea based on a sterilization method that did not exist. His screwworm work was interrupted for more than a decade, by World War II among other things. Then, in 1950, he learned from Nobel Laureate Hermann J. Muller about the possibility of using x rays and gamma rays to sterilize the flies.

In 1954, USDA scientists working under Knipling's direction demonstrated the idea would work by releasing gamma ray-sterilized flies on Curacao, a Caribbean island. Within about 3 months, the screwworm population was annihilated.

By 1959, screwworms were eradicated from the southeastern United States and by 1966 were strongly suppressed in the Southwest, through cooperation with Mexico. The pest has since been eradicated from all of the United States and from most of Mexico. The savings to ranchers amount to hundreds of millions of dollars a year.

But you'd have to be in the livestock business to fully realize what this accomplishment has meant. As Ed Ketchum, president of the Southwest Animal Health Research Foundation, tells it: "Knipling completely changed the way ranchers operate. We wouldn't know what do with a cow infested with screwworms now because we haven't seen any cases in so many years. Cowboys used to ride the range every other day searching for infested cows. They'd put medicine on the wound to repel the flies and kill the worms, but the treatment only worked a day or two, at best. Now they don't have to, and we couldn't afford it anyway. I don't know of any other program so supported by ranchers or of anyone who has had such an impact on the industry."

Spurred by this success, Knipling turned his inventiveness to possibilities for controlling other formidable pests. Considering a variety of techniques—control with parasites and predators and with insect attractants and repellants, as well as sterilization—he proposed new ways to control: Mexican, Mediterranean, and oriental fruit flies; pink bollworms; codling moths; boll weevils; gypsy moths; mosquitoes; tsetse flies; ticks; and many other pests.

Although he is best known for his efforts to eradicate the screwworm, Knipling's greatest contribution has been his leadership in advancing, to an unprecedented extent, the science and technology of insect control. He served as director of entomology research at the Agricultural Research Service from 1953 to 1971. Under his leadership, most of the agency's entomology research was redirected from the development of nonselective insecticides to biological and other selective controls. Much of the redirection had been done by the time Rachel Carson published her landmark book on the dangers of broad-spectrum insecticides, "Silent Spring" (1962).

For his leadership and scientific accomplishments, Knipling has received many awards nationally and internationally. Most recently, ARS named him the first inductee into the agency's Scientific Hall of Fame. A plaque honoring Knipling will be on permanent display in the planned National Visitor Center at Beltsville, MD.

With this award, ARS officially honors its outstanding and highly successful scientists whose careers exemplify their deep commitment to serving the public through agricultural research. Knipling is an excellent choice as the award's first recipient. No one else has made such contributions. It's not only the payoffs such as the screwworm eradication that are important, but the fundamental concepts behind those payoffs. Those same principles can be applied to a dozen or more other major pests, some of which are even more important to the agricultural economy of the United States than the screwworm was. That's Knipling's legacy to ARS: a challenge to use his concepts to control these pests within the next 20 years.

Terry B. Kinney, Jr.,
Administrator

Though retired, Knipling serves as a pest management collaborator for ARS at Beltsville, MD. (0686X756-34a)

Agricultural Research

COVER:
As part of the Agricultural Research Service's ongoing efforts to assist Great Plains farmers who return to dryland farming, biological aide Joseph Bryan checks depth of water conserved with a level terrace system.
Terraces not only reduce soil erosion on dryland farms but also allow storm water to soak into the soil instead of running off the land. Story begins on page 6. (0686X703-27)

p. 4

p. 13

p. 15

6 Shutting Off the Water

More and more farmers in the Great Plains are looking to dry land agriculture to survive.

12 Duckweed May Unlock Sunflower's Secret

A tiny pond-floating weed may hold the key to giving major crops the ability to produce their own herbicides.

13 Genetic Defect Could Signal Heart Disease

A gene mutation has been found that may be used to identify children predisposed to heart trouble in later life.

DEPARTMENTS

4 Agnotes:

Sore Muscles: Studies Offer New Clues
Sugar Byproduct Removes Bitterness From Grapefruit Juice
Juice Bitterness May Be Blocked With Hormones

14 Technology:

New Cotton Processing System Saves Energy, Cuts Pollution
Tank Provides New Home for Pickling

16 Patents:

Papaya Wax Component Removed by Freeze Drying
Purple Color Signals Almond Contamination
Debittering Citrus Juice with Cyclodextrin Polymers

Vol. 34, No. 7
August 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Daniels
Art Director: Deborah Taylor

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

Sore Muscles: Studies Offer New Clues

After exercise, why do one person's muscles ache and another's feel fine?

One group of volunteers breezed through a 45-minute bout on a stationary bicycle, reporting almost no soreness in their thigh muscles afterward. But another group found it hard to move normally a day or two later.

At first glance, the results were predictable: Those in the first group were distance runners who trained daily; those in the second group were sedentary men who exercised infrequently. What is new is that through such studies, scientists are beginning to understand why training makes a difference in the body's response to exercise.

Muscle damage causes the soreness 24 to 48 hours later, and several studies now point to the "eccentric part of exercise as the culprit," says William J. Evans, who conducted the exercise study at the Agricultural Research Service Human Nutrition Research Center on Aging at Tufts University in Boston. Eccentric exercise occurs when muscles lengthen as they produce force, as in lowering a weight or walking downstairs.

A volunteer exercises at the Human Nutrition Research Center on Aging while technicians monitor his heart rhythm and oxygen consumption. (0286X130-32)

Trained athletes don't suffer from sore muscles because their muscles have "learned" how to stretch without tearing and their bodies are already geared up to repair any damage quickly, says Evans, whose research is funded by the Agricultural Research Service. His studies show that individual muscle fibers tear apart at a "weak link" known as the Z disk.

According to Evans, the five sedentary volunteers responded to this damage much like they would to an infection—by producing large amounts of interleukin-1, a polypeptide known to be part of the body's immune system. "Interleukin-1 apparently triggers a sequence of events leading to repair of damaged muscle fibers," he says.

"Before muscles can be repaired," he says, "damaged proteins have to be broken down and disposed of and new proteins synthesized." Blood and urine samples taken during the exercise study showed that "muscle damage was more severe in the sedentary men and the repair process was much slower."

The runners in the study maintained high blood levels of interleukin-1, which did not significantly rise after cycling for 45 minutes. "In other words," Evans says, "the runners have the jump on muscle repair, if repair is needed."

His laboratory is looking into how this happens and how the muscles in elderly men repair the same type of damage. The answers may take several years of research because the system is complex.

"Unfortunately," he says, "regular eccentric exercise doesn't protect other muscles in the body against damage. If a runner were to chop wood for several hours, he or she would experience just as much soreness in the upper body as the sedentary person."

"Eccentric exercise requires less energy than other exercise, but its delayed effects may cause greater changes in body metabolism and damage to muscle tissue," Evans says.—By **Judy McBride,** ARS.

William J. Evans is at the USDA-ARS Human Nutrition Research Center on Aging, 711 Washington St., Boston, MA 02111. ■

Sugar Byproduct Removes Bitterness From Grapefruit Juice

A byproduct from the manufacture of corn sweeteners has the unusual ability to trap and remove the sources of bitterness in grapefruit juice and navel orange juice, reports a chemist with the USDA's Agricultural Research Service in Winter Haven, FL.

The trapping agent, says the scientist, is cyclodextrin polymer, a sugar byproduct that is chemically treated, or polymerized, to make it inert and insoluble in water.

Once treated, the substance, which resembles fine, white sand, can be used as a "bitterness filter" for citrus juice, according to Philip E. Shaw.

In Shaw's laboratory model, grapefruit juice is pumped through 18 inches of cyclodextrin contained in a glass column 3 inches in diameter. The cyclodextrin is agitated to permit the citrus pulp to pass through along with the juice.

"The big molecules of the sources of bitterness in grapefruit juice—limonin and naringen—get physically stuck inside the holes of the donut-shaped molecules of cyclodextrin," explains Shaw, "where they are held in place by a weak chemical bond."

Enough of the bitter substances are taken out, he believes, "to make the juice much more acceptable to consumers."

He adds that vitamin C, sugar, and other nutrients in the juice pass right through the holes.

When the cyclodextrin has ab-

Scientists C.W. Wilson (left) and Philip Shaw watch as early season grapefruit juice is pumped through a tube, where the juice's bitterness is removed by donut-shaped molecules of cyclodextrin. (PN-7206)

sorbed all the bitterness it can, the limonin and naringen can be washed out with a weak alkaline solution and the cyclodextrin cleaned, sterilized, and used again.

"While many consumers of grapefruit juice undoubtedly enjoy some degree of bitterness," the research chemist says, "the chief concern of the industry is with early season grapefruit. These are typically so bitter that their juice has to be mixed with juice from midseason and late grapefruit to make it palatable."

"This is a costly operation, since it requires holding and refrigerating large quantities of juice over several months."

One bitterness agent in grapefruit—limonin—is also found in the juice of navel oranges, according to Shaw.

Approval of the federal Food and Drug Administration will have to be obtained before cyclodextrin polymer can be used commercially to debitter juice.—By **Hubert Kelley,** ARS.

Philip E. Shaw is at the USDA-ARS Citrus and Subtropical Products Laboratory, P.O. Box 1909, Winter Haven, FL 33883-1909. ■

Juice Bitterness May Be Blocked With Hormones

Natural bitterness in juice from navel oranges may someday be prevented by feeding orange trees small doses of natural plant hormones known as auxins.

Agricultural Research Service chemist Shin Hasegawa, at Pasadena, CA, has found auxins that are expected to successfully block formation of a compound that leads to bitterness in juice from navel oranges. Normally, the juice turns bitter just hours after it is extracted. Bitterness is not a problem, however, with navel oranges that are eaten fresh.

The auxins work by inhibiting production of nomilin, a compound needed for production of a second chemical—limonin. It is the limonin that causes extreme bitterness in navel oranges, especially early season fruit.

Earlier work by Hasegawa and colleagues provided new details on how limonin and nomilin are formed in citrus cells and led to the experiments on how to block this natural chemical process.

In greenhouse tests, the scientists fed tiny quantities of auxins to lemon seedlings for 3-day periods. The applied auxin blocked up to 97 percent of nomilin production. The auxins were just as effective on a few older, fruit-bearing trees.

Although Hasegawa used lemon trees for the experiments, he expects similar results in planned experiments with oranges because the bitterness-formation process is the same in both fruits. He began the tests with lemon trees because, in California, these trees bear fruit almost year-round.

The findings could lead to an expanded market for juice from California and Florida navel oranges. Currently, only limited amounts of navel orange juice are mixed with juice from other oranges. The bitterness problem costs California navel orange growers an estimated $6-$8 million each year in lost juice sales.

Most commercially processed orange juice has no more than 2 parts per million of bitterness agents, according to Hasegawa. Valencia orange juice has less than 2 parts per million of these bitterness compounds, while navel orange juice can easily contain from 15 to 25 parts per million.

The auxin approach differs from other methods proposed in recent years for debittering juice from navel oranges and other citrus because it focuses on changing the tree's chemical makeup. In contrast, other approaches require treating freshly squeezed juice with bacteria, resin, or other materials. *[See "Sugar Byproduct Removes Bitterness" on page 4.]*

If successful in field tests, auxins may offer the advantages of low cost and convenience. One of the auxins tested, 1-naphthaleneacetic acid, is safe, inexpensive, and readily available. It is routinely used on apples, pears, and grapes.

Field tests should indicate how often the auxin should be applied, and the ideal amount and concentration to use. "We'll also find out if there are any negative effects on the tree or its fruit," Hasegawa says.—By **Marcia Wood,** ARS.

Shin Hasegawa is at the USDA-ARS Fruit and Vegetable Chemistry Laboratory, 263 South Chester Ave., Pasadena, CA 91106. ■

Shutting Off the Water

Water content of soil below bench terraces is measured periodically by Larry Fulton, ARS technician at Bushland, TX. Aim of the work is to develop better cropping and terracing systems that conserve water, increase yields, and protect soil from erosion. (0686X711-11)

"I didn't water my crops last year, and I won't water them this year," says Robert Jacobson, a farmer in the West Texas Panhandle.

Jacobson wouldn't have considered saying that a few years ago. When he and his father started irrigating their wheat in 1954, they found that they could afford supplemental irrigation on more than 2,800 acres.

But 2 years ago, changes in the economics of farming—costs vs. income—prompted Jacobson to take a hard look at the wisdom of irrigating at all. When he examined all the options, he decided to return to dryland farming.

Before the oil embargo of 1973, says Bobby A. Stewart, an Agricultural Research Service soil scientist at Bushland, TX, natural gas used to pump irrigation water cost only 37 cents for 1,000 cubic feet. By 1985, the cost had climbed about 1,100 percent, to $4 per 1,000 cubic feet.

On the other hand, as recently as 1982, the average price farmers in the Texas High Plains received for a bushel of wheat was $3.61. By June 1986, the price had fallen to $2.20-$2.45, down more than 35 percent from 4 years ago.

"Faced with a combination of low commodity prices, high fuel costs, and deeper wells, it isn't hard to see why farmers like Bob Jacobson decided that they had better learn to survive without irrigating."

—Soil Scientist **Bobby A. Stewart**

Furthermore, many irrigators in the Great Plains pump their water from the vast Ogallala aquifer, an underground reservoir that stretches from South Dakota to Texas. While only 5 percent of the 3.2 billion acre-feet of water in the Ogallala has been tapped so far, hydrologists say that Texas has pumped nearly a fourth of the water from its portion of the Ogallala. As the water table falls beneath the High Plains, farmers have to use more and more fuel to pump the same amount of water up to ground level.

Every year, more farmers join Jacobson in returning to dryland farming in this region, where the major dryland crops are winter wheat, cotton, and grain sorghum. Irrigated farming zoomed after the end of World War II, and irrigated acreages in the southern High Plains kept climbing until the peak year of 1978. After that, they began to decline. Texas had a high of 6.9 million acres of irrigated farmland in 1978; by 1984, the acreage had fallen to 4.9 million. It was a similar story in New Mexico, which had 891,000 irrigated acres in 1978 and only 674,000 acres in 1984. Oklahoma had 602,000 irrigated acres in 1978 and 439,000 acres in 1984—the lowest irrigated acreage since the mid-1960's.

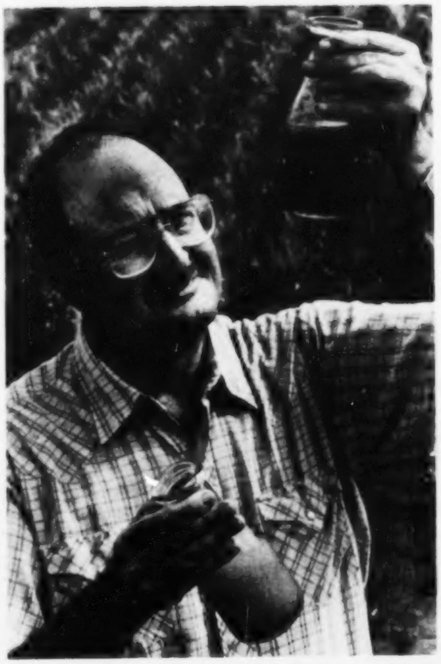
And the downward trend continues because of dollars and cents reasons.

"Obviously, there are risks inherent in abandoning irrigated farming in a region with uncertain rainfall, like the southern High Plains," says James F. Parr, the ARS national program leader for dryland farming. "Rainfall in any given year can range from 10 inches or less up to 30 and more. But I think we know enough about farming this region today to avoid another Dust Bowl, even after a prolonged drought."

Parr is convinced that the use of modern farming techniques, many of them developed by ARS researchers throughout the Great Plains, will help farmers avoid the mistakes of the past.

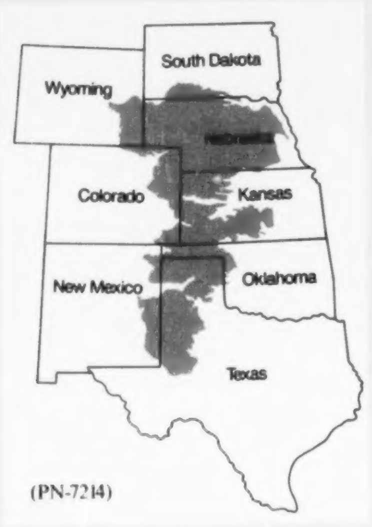
"When cropping started in the Plains, farmers used the same methods that they were familiar with in the wetter states to the east. This worked when there was adequate rainfall, but when the dry years came, it was a disaster," he says.

"We exploited the Great Plains for years because we didn't know how to manage them," Parr says. "Today we know a great deal about soil and water management that we didn't know then,



Above: A recent convert to dryland farming in the Texas High Plains, Paul Jacobson (on spray rig) applies herbicide on no-till field before planting grain sorhgum. His father, Robert (right), discusses water-saving effects of crop residues with O.R. Jones of ARS. (0686X707-17A)

Left: O.R. (Reggie) Jones, ARS soil scientist, examines runoff, dark with sediment, from conventionally tilled field. The other bottle, practically sediment free, contains runoff from no-till field. (0686X706-31)



(PN-7214)

The Ogallala Aquifer

It's ironic that beneath the Dust Bowl lay a water reservoir slightly larger than all of California.

Although the technology needed to tap it for irrigation wasn't there when needed most, the Ogallala aquifer has been heavily pumped since the drought of the 1950's.

The Ogallala is actually water that has seeped into what was, more than 2 million years ago, a seabed. The bed—deposits of sand and gravel eroded from the Rocky Mountains—extends from South Dakota down to Texas and New Mexico. It is made up of three somewhat connected geologic units—the Brule Formation, the Arikaree Group, and the Ogallala Formation—with the Ogallala being the largest.

The aquifer's thickness varies from less than 50 feet in the southern High Plains of Texas to as much as 1,200 feet in Nebraska.

The region over the Ogallala is generally semiarid, so the ground water recharge from precipitation is extremely small, estimated to be one-half to 2 inches a year. No water flows into the Ogallala from outside the region.—**D.C.** ■

Fifty years old but still effective against wind erosion on sandy soil is the "West Texas sandfighter." As tines on the machine cut through wet soil, they throw up clods that are too big to blow away. Clods on a soil's surface can cut erosion rates by 75 to 80 percent. (0686X693-21)

and we have developed effective practices and the mechanisms for applying that knowledge. We also have a better understanding of wind erosion and how to prevent it."

It is no single discovery that makes possible a profitable return to dryland farming. Rather, it is a combination of better crops, better farming methods, and better resource management.

O.R. (Reggie) Jones, a soil scientist at Bushland, in the Texas Panhandle, says that "the biggest single factor in preventing another Dust Bowl is what we have learned about water conservation, including leaving crop residues on the surface of the soil to improve rainfall infiltration and slow down evaporation. But we also understand the weather and climatic patterns much better and we have adapted our methods to those variables. And we have better crop varieties.

Another factor that seems more important every year is weed control with herbicides. Weeds are a big competitor for water, and chemical weed control is contributing a lot to increased yields."

Here are some of the specific techniques developed through years of research and field trials that are encouraging the region's farmers to assume the risks of dryland farming:

- *Water conservation and conservation tillage.* The main emphasis of dryland agriculture is to use farming methods that retain rainfall, reduce evaporation, and take advantage of the

rainfall patterns. Where research is perhaps paying off the most, Jones says, is in helping farmers stop the rain from running off the land.

Leaving crop residues on the field instead of plowing them under protects the soil surface, reduces evaporation, and keeps soil pores open so water can infiltrate.

According to Jones, in comparison with tilling a field clean, stubble mulch tillage—leaving crop residues on the field after harvest—conserves 20 percent more water and soil. On fields in the Texas High Plains, stubble mulching increases wheat yields about 12 percent over conventional tillage. And higher yields lead to more residue on the surface for the next crop.

- *Terraces and dikes.* Bench terraces are also used on gentle slopes to conserve water that would otherwise run off and be wasted. Designed like stair steps, the terraces catch rain water in May and June and hold it in the topsoil so the plants can use it in July and August. Jones says large benches conserve enough additional water that farmers can plant a crop each year on the level bench.

Furrow dikes are small, temporary soil-packed dams across the furrows to trap rainfall and keep it from running off. They were used in the Great Plains in the 1930's but were abandoned for several reasons, including poor weed control and erosion when dams washed out. Agency engineers helped revive the practice in 1975, by designing better equipment to make the dams and using the dikes in summer crops when the potential for runoff is highest. In the southern High Plains, there are over 2 million acres with furrow dikes.

- *Weed control.* In reduced tillage or no-till systems, farmers use herbicides to prevent the growth of weeds that would steal away scarce water. Herbicides developed since the late 1960's now allow farmers to grow crops in rotations with fallow periods. In the southern High Plains, including a fallow period in crop rotations can markedly increase the amount of water stored in the soil. A rotation of dryland winter wheat/fallow/grain sorghum, with no-till after sorghum, adequately maintains residues, and compared with tilled-field tests, yields are just as high for wheat and 20 percent higher for grain sorghum.

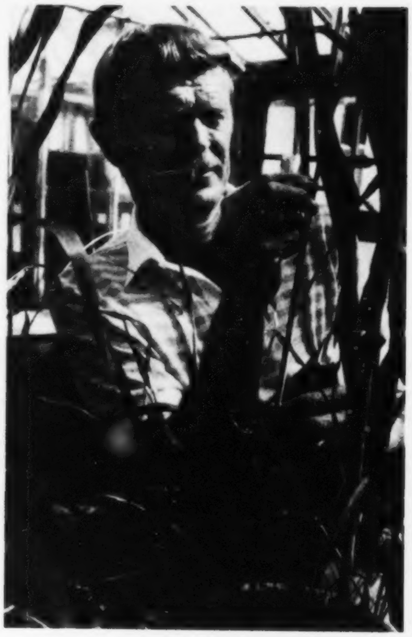
- *The "Sandfighter."* Agency researchers have one simple answer to soil-blowing wind—create rough clods on top of the soil to make the surface too heavy for wind to lift away. Surface clods resist wind erosion, help anchor mulches, slow runoff water, provide shade, and physically protect young plants. But rain falling on bare soil smooths out the surface. When the soil dries, particles of sand are picked up by the wind. And wind-blown sand

Bobby Stewart, who leads the conservation research at Bushland, TX, reports that Panhandle farmers are turning to dryland farming in greater numbers as irrigation costs rise and crop prices decline. Stewart has spent his life conserving soil and water in the Dust Bowl area. (0975X1926-33)

An ARS invention provides dryland farmers with an early warning — maybe 2 to 16 weeks ahead of time — of fields that may erode in severe windstorms. The Big Spring (Texas) Dust Sampler, invented by ARS scientist D.W. Fryrear, detects subtle changes in erosion patterns, giving farmers time to protect endangered fields by using corrective tillage implements. (0686X696-31A)

ARS soil scientist Jean Steiner checks instrumentation used for evapotranspiration research on dryland wheat. Precise field measurements help researchers develop cropping systems with improved water-use efficiency. (0686X710-1)

Right: James Parr, ARS scientist and authority on dryland farming, studies new varieties of drought-resistant millet. Parr is convinced that another Dust Bowl can be prevented, even after prolonged drought, with better water conservation, residue tillage, and improved dryland crop varieties. (1085X1120-33)



can destroy a crop, especially young emerging plants, in 15 to 20 minutes.

D.W. (Bill) Fryrear, an ARS research leader in Big Spring, TX, advocates the "West Texas sandfighter" to make the clods. Designed by area farmers in the 1940's, this simple implement attaches to a tractor and roughens the soil to minimize wind erosion. Its 2-inch-wide pointed metal tines compact the soil, leaving small holes about 4 inches wide by 5 inches long. In a day, one person can cover 600 to 1,000 acres. Using the sandfighter is most effective in sandy soils and right after planting crops that do not provide a good residue cover. In one study, creating surface clods reduced soil loss by 75 to 80 percent.

- *Cropping Practices.* A 3-year rotation of wheat, sorghum, and fallow also reduces soil erosion while providing crops with adequate water.

Leaving crop residues on the field instead of plowing them under protects the soil surface so raindrops can't break up and wash away soil. In field tests in Bushland, annual soil losses during the wheat crop rotation sequence were less than half a ton per acre when either no-till or stubble-mulching was used.

Crop planting times can be tied to when the rain will probably fall. Stewart says computer models could help farmers plan more effective seeding dates. A computer model takes into account each stage of a crop's life cycle and when it needs water the most. The model counts the days of higher temperatures and the probability of rainfall to suggest a planting time that matches the cropping pattern to the climate. Such planning allows the water to be used by the plants rather than be lost through evaporation.

The major drought-tolerant crops are winter wheat, grain sorghum, and cotton. But cotton, the dryland crop with potential for the greatest net return per acre, produces less residue than wheat or sorghum and has been the cause of substantial wind erosion in the High Plains.

New varieties of winter wheat, adapted to dry conditions in the southern Great Plains, have also contributed to higher yields for dryland farmers.

Assistance to Great Plains Farmers

ARS and others communicate results of research in the Great Plains to farmers in several ways. Information and direct assistance is given through state and federal agencies, universities and Cooperative Extension agents, and local soil and water conservation districts.

Also working closely with ARS over the years has been another USDA agency, the Soil Conservation Service. This agency administers a special program established by Congress in 1956— the Great Plains Conservation Program (GPCP). This program provides technical assistance and long-term cost sharing to farmers and ranchers to help them minimize the hazards of recurring drought and soil erosion.

The 518 counties covered by the Great Plains program have 127.5 million acres of cropland, of which about 19 million acres have been covered by GPCP contracts. In the southern High Plains, most of the help to dryland farmers has been for terracing; conservation tillage practices are not approved for GPCP cost sharing in Texas and Oklahoma, but are in several northern Great Plains states.—By **Dvora Aksler,** ARS. **Sean Adams** and **Hubert Kelley,** ARS, contributed to this article.

Bobby A. Stewart and O.R. (Reggie) Jones are at the USDA-ARS Conservation and Production Research Laboratory, P.O. Drawer 10, Bushland, TX 79012. D.W (Bill) Fryrear is in USDA-ARS Wind Erosion and New Crops Research, P.O. Box 909, Big Spring, TX 79720. James F. Parr is on the USDA-ARS National Program Staff, Room 415, Bldg. 005, Beltsville Agricultural Research Center, Beltsville, MD 20705. ■

Prospects for survival were dim in 1937 for farmers in the Dust Bowl's 20 counties. Owners of this farm near Guymon, OK, threw in the towel, packed up, and headed West. (OKLA-198; USDA Soil Conservation Service photo by B.C. McLean, 10/5/37)

America's Dust Bowl of the Past

In the mid-1930s, what became known as the Dust Bowl was a relatively small part of the Great Plains, consisting of 20 counties located in the northern Texas Panhandle, Oklahoma, Kansas, and Colorado.

Within this small area, more than 8.7 million acres had been "severely damaged" by 1937, and an additional 7 million acres had been "damaged slightly." Hardest hit was Baca County, in the southeast corner of Colorado, with more than 1.1 million acres badly damaged by drought and wind.

Parts of the Dust Bowl appeared so desolate that some agriculturists doubted the area could ever be reclaimed, but would remain "a desert in perpetuity." USDA scientists and field workers, however, took a more positive view and set about reclaiming the area with plantings of native grasses and with other measures.

Asked why the Dust Bowl had happened, Arthur H. Joel, a spokesman for the Soil Conservation Service, said in 1937, "...the protective vegetation cover had been destroyed or seriously depleted over a large portion of the country by cultivation, overgrazing, drought, and other causes. This destruction of vegetation and the failure to provide adequate protective substitutes, such as crop stubble, crop residues, cover crops, strip crops, and suitable tillage, are generally considered to be the chief causes of the present critical condition."

In the 50 years since, conservation researchers, many centered at Bushland, TX, in the old Dust Bowl, still agree with Joel's observations.— **H.K.** ■

Duckweed May Unlock Sunflower's Secret

Plant physiologist Gerald Leather observes reduced growth and reproduction of duckweed previously exposed to plant-made herbicides known as allelochemicals. (0486X534-25)

Nature's own herbicides—allelopathic chemicals made by some plants to kill others—are getting tryouts for future roles in agriculture.

The first auditions, though, are not performed on acres of weeds, as one might expect, but on plants no bigger than aspirin tablets.

Says plant physiologist Gerald R. Leather, "The tiny duckweed is a pond-floating plant that gives scientists the economy of size needed to unravel the complex chemistry of allelopathy."

Leather, with the Agricultural Research Service in Frederick, MD, is among a small corps of scientists studying the mechanics or underlying secrets of how sorghum, sunflowers, and other plants do chemical combat with neighboring weeds.

He and plant physiologist Frank A. Einhellig from the University of South Dakota recently developed a duckweed bioassay or tissue test that for the first time will allow scientists to reliably detect the herbicide action of minute quantities of many allelochemicals.

It is difficult to study these chemicals because nature puts very little into each plant.

However, using the new test, Leather can trace the impact of an allelochemical on duckweed tissue in amounts as small as a few parts per billion. He says it's "like measuring a salinity effect of one grain of salt in a jug of water."

Not only sorghum and sunflowers, but also oats, walnut trees, some varieties of cherry and cucumber, and many weeds make forms of allelochemicals.

A popular theory among plant scientists is that many of our highly bred crop plants have lost an inherent allelopathic ability to fight off neighboring weeds for essential sunlight, soil nutrients, and water.

Some crops, such as cucumber and sunflower, the theory continues, are not as far removed from wild relatives and may have retained the ability.

Leather says that research could lead to more weed-competitive crop plants with allelochemicals added through breeding and genetic engineering.

Chemist Edward J. Saggese at the agency's Eastern Regional Research Center in Philadelphia, PA, has designed a laboratory procedure to help Leather recover active allelochemicals from extracts of plants. Saggese and fellow chemist Thomas A. Foglia use the procedure to refine up to eight chemical fractions from each extract.

Leather tests the fractions for herbicidal action on duckweed. Then the chemists further break down those fractions that have an effect into dozens of individual compounds for further testing on duckweed.

Leather's test consists of dropping a different compound into each of 30 tiny "ponds" in a wallet-sized plastic plate. Each pond contains a duckweed. "The beauty of it is that each test plate is essentially an acre of field tests in the palm of my hand," he says.

Scientists have learned that plants use their allelochemicals in various combinations and degrees.

Complicating things further, they've found that tissues of some species can contain levels of a chemical that would actually injure those plants if sprayed onto their surfaces.

For example, Leather found that sorghum can absorb and chemically tie up an allelochemical called salicylic acid that it produces. Up to a certain level, salicylic acid does no harm because the plant somehow stops the chemical from moving freely in its tissues.

> ***"The beauty of it is that each test plate is essentially an acre of field tests in the palm of my hand."***
>
> —Plant Physiologist **Gerald R. Leather**

It may be many years, says Leather, before the work leads to commercial herbicides or to crops bred to carry allelochemicals. However, the preliminary research is beginning to answer some long-held questions.

"We are finding out why a garden pole bean refuses to climb a sunflower stalk, for instance, or why tomato vines won't grow near a walnut tree. On the farm, we are learning why seedlings of one crop may have to struggle to sprout from under the residue of a previous one."—By **Stephen Berberich,** ARS.

Gerald R. Leather is in USDA-ARS Weed Science Research, Fort Detrick, Bldg. 1301, Frederick, MD 21701. ■

Genetic Defect Could Signal Heart Disease

A newly discovered gene abnormality could prove invaluable in identifying people predisposed to heart disease, say two researchers at USDA's Human Nutrition Research Center on Aging at Tufts University in Boston.

Jose M. Ordovas and Ernst J. Schaefer, working with an international team of scientists, found the gene abnormality in 32 percent of patients with premature coronary artery disease (under the age of 60) and in 66 percent of people having too little high-density lipoprotein (HDL)—a substance in the blood that prevents clogging of the arteries. Only 4 percent of the control subjects had the abnormality.

Ordovas, Schaefer, and six other scientists in the United States, Canada, and Italy published these findings earlier this year in the *New England Journal of Medicine.* USDA's Agricultural Research Service, the National Institutes of Health, and the Charles A. Dana Foundation provided the major funding for this work at Tufts.

"If further research confirms our findings," says Ordovas, a biochemist and molecular biologist at the center's Lipid Nutrition Laboratory, "individuals having the abnormality could be identified before they develop heart disease and counseled to change diet and smoking habits to reduce risk." The ideal, he says, would be to identify the abnormality in very young children before they have developed poor dietary habits or started to smoke.

According to Schaefer, who heads the lipid lab and teaches medicine and nutrition at Tufts University, HDL tends to prevent cholesterol deposition on artery walls. So having low plasma levels of HDL increases the risk of heart disease for individuals consuming a typical American diet.

Molecular biologist Jose Ordovas (left) and endocrinologist Ernst Schaefer search for a defective gene among the small portion of the DNA in a human chromosome. The gene may help physicians identify people predisposed to heart disease. (0286X121-33)

Schaefer says the mutation is adjacent to the gene that codes for the major protein of HDL, known as apolipoprotein A-1. It's this protein that actually binds to the cholesterol, forming what is popularly known as the "good cholesterol."

"Low plasma levels of HDL-cholesterol and its major protein—apolipoprotein A-1—have been shown to be strong biochemical indicators that a person will develop coronary artery disease before age 60," says Schaefer.

Locating the mutation was the first step in determining how it reduces circulating HDL. According to Schaefer, his group is in the process of decoding the abnormal gene with the mutant portion. "Within the next year," he says, "we hope to know precisely how the mutation affects the production of apolipoprotein A-1, which, in turn affects the levels of HDL."—By **Judy McBride,** ARS.

Jose M. Ordovas and Ernst J. Schaefer are at the USDA Human Nutrition Research Center on Aging, 711 Washington St., Boston, MA 02111. ■

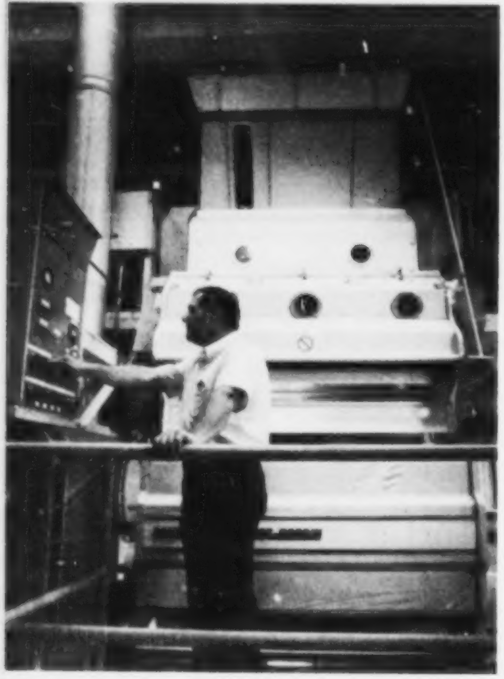
TECHNOLOGY

New Cotton-Processing System Saves Energy, Cuts Pollution

The machines for removing cotton lint from cottonseeds have steadily improved since Eli Whitney patented the first cotton gin in 1794. Now Agricultural Research Service researchers in Mesilla Park, NM, are speeding up this evolution even more to save energy, cut dust pollution, and in the process produce better quality lint.

Engineer Ed Hughs thinks they have accomplished their goal. The new ginning machine put together at the Ginning Research Laboratory takes seed cotton in one side and puts out clean cotton lint on the other side ready for baling. It eliminates the need for three separate machines and massive air ducts to move the cotton between these machines.

Without the air-handling system, electric power consumption is reduced. Hughs estimates a typical cotton gin could cut overall power costs 20 to 40 percent. Cyclone dust collectors now used in cotton gin buildings would be largely unneeded or smaller—saving power and equipment costs, as well as reducing chances for air and noise pollution.



Agricultural engineer Marvis Gillum at console of the prototype gin/cleaner that is designed to take the place of three presently used machines. (0586X582-3)

Hughs does not expect the new combined gin and lint cleaner to replace existing equipment unless a cotton ginning operation is undergoing modernization. Gin numbers have dropped to about 1,700 in the United States, down from 2,800 about 10 years ago. "But overall capacity hasn't dropped that much," Hughs says. "This trend toward larger operations should make it easier for advanced equipment such as ours to gain acceptance."

The prototype did not come easily, says Hughs. "After much work and borrowing as many commercially available parts as possible, we had the combined gin-lint cleaner ready for tests last fall." These tests at Mesilla Park were successful. The quality of cotton fiber coming out of the machine was generally as good as that from three separate conventional machines.

ARS textile technologist Charles K. Bragg at Clemson, SC, will do further testing during 1986 to verify that fiber from the new machine is as good as conventionally processed fiber for making into textiles.

The next step will be for the engineers to connect a computer to the machine to further improve efficiency. The computer could control how fast raw seed-cotton can be fed to the machine, check for proper moisture content to maintain highest quality, and control trash removal.—By **Dennis Senft,** ARS.

Ed Hughs is located at the USDA-ARS Southwest Cotton Ginning Research Laboratory, P.O. Box 789, Mesilla Park, NM 88047. Charles K. Bragg is at the USDA-ARS Cotton Quality Research Station, P.O. Box 792, Clemson, SC 29631. ■

Tank Provides New

Centuries-old picklemaking techniques—in outdoor tanks of salt brine—may change as a result of U.S. Department of Agriculture research.

Ten companies throughout the nation are testing a process that relies on the old-time fermenting of cucumbers in brine but uses a new closed tank sealed from air and sunlight, says Henry P. Fleming, an Agricultural Research Service scientist at Raleigh, NC.

Currently, tanks are left open outdoors so the brine is exposed to sunlight, which prevents growth of molds, yeasts, and bacteria that can spoil pickles.

As extra protection outdoors, companies use more salt than necessary for picklemaking to guard against contamination from rainwater and foreign material and to prevent freezing. But the added salt must be removed before pickles are sold. That has been causing disposal problems for some pickle companies because waste brine may contain too much salt to meet federal water-quality regulations.

Closing the tank overcomes the old drawbacks, says Fleming, a food technologist. Salt usage is less. Sunlight is no longer needed since the tanks are sealed off from the air, creating an oxygen-free, or anaerobic, environment. Inside the sealed tanks, microorganisms that could cause spoilage cannot grow.

Picklemakers will also be able to control the environment in which desirable bacteria ferment cucumbers into pickles, Fleming says. These bacteria convert sugar in cucumbers to lactic acid, giving pickles their sour taste and preserving them.

Until now, the industry has not used the closed tanks because carbon dioxide gas, which forms during fermentation, must escape through the open tops. Otherwise, the gas can bloat pickles or even rupture the tanks.

Agency scientists discovered in the 1970's that the carbon dioxide could be removed by bubbling nitrogen gas through the brine. That technology

Home for Pickling

opened the way for the closed tanks, Fleming says.

Raleigh scientists are exploring new procedures to be used with the tanks. Microbiologist Mark A. Daeschel is studying ways to genetically engineer organisms to use in the closed tanks. These new organisms could ferment pickles with new textures and flavors, Fleming says.

As a precaution, biochemist Roger F. McFeeters is studying lactic acid-converting bacteria and potential problems that storing pickles at low salt concentrations could create.

Before 1940, virtually all pickles were made by brining, but now only about 40 percent are made that way. Two other pickling methods—pasteurization and refrigeration—have come into use since the 1940's.

But Fleming says old-style fermenting has economic advantages—rapid and temporary preservation, low energy costs, and spreading out the processing season to distribute labor and equipment costs.

The prospects of less salt, lower costs, and better products have excited picklemakers. The 10 companies this year are each testing at least two tanks, and if they are used commercially on a large scale they may "eventually revolutionize the way the industry produces pickles," he says.

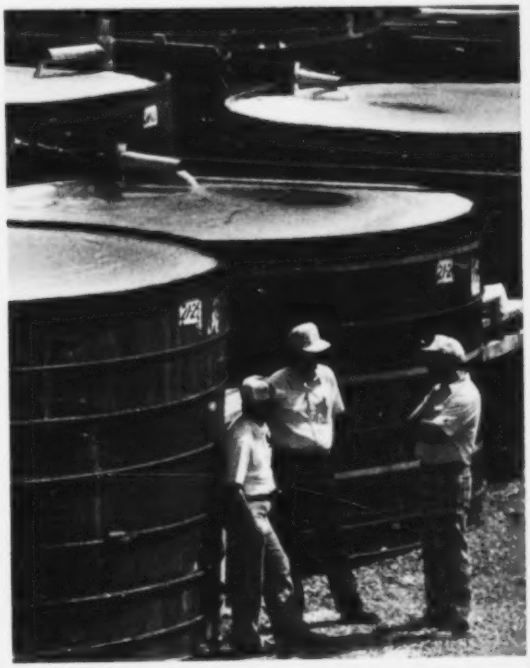
The test tanks each hold 8,300 gallons and are 12 feet in diameter. Fleming, engineer Ervine G. Humphries of North Carolina State University, and the industry representatives designed the tanks. The companies paid for the tanks and for a pilot plant at the Mt. Olive Pickle Co., Mt. Olive, NC.

Fleming says the companies are test-marketing the pickles and that he is testing them to see how well they keep in storage.—By **Sean Adams,** ARS.

Henry P. Fleming is in USDA-ARS Food Science Research, Box 7624, North Carolina State University, Raleigh, NC 27695. ■

Food technologist Henry Fleming (left) and cooperating North Carolina State University scientist Ervin Humphries in front of experimental closed-top pickling tanks at the Mt. Olive Pickle Company. (0686X749-15)

Above: Fleming at top of closed type of pickling tank which has a 30-inch diameter port through which the tank is filled and emptied. (0686X750-24)



At traditional open-top tanks used by the pickle industry, processing methods are discussed by Humphries (left); Fleming (center); and Douglas Brock, of the Mt. Olive Pickle Company, chairman of the Closed-Tank Task Force for Pickle Packers International. (0686X750-9)

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

Papaya Wax Component Removed by Freeze Drying

Scientists have found a better way to remove cutin from the outer layer of papaya.

Cutin, a valuable component of the plant cuticle, serves as a barrier to harmful pests. It is being used in research to study cutinase, an enzyme produced by certain fungi that allows them to invade the cuticle and destroy fruit.

Previously, cutin was removed from papaya by immersing the fruit in heated solvent chemicals or by freezing the fruit and then rinsing it in hot water and scraping its outer surface.

With the new process, the papayas are freeze-dried so that the inner fruit shrinks and the outer, cuticle layer becomes separated. Then the cutin is mechanically brushed from the surface. The new method is less laborious than the old and eliminates the need for hot solvent chemicals.

For technical information, contact Harvey T. Chan, Jr., at the USDA-ARS Hawaiian Agricultural Experiment Station, Waiakea Farm, P.O. Box 917, Hilo, HI 96720. *Patent No. 4,421,775, "Method for Removing the Outer Waxy Cutin-Containing Layer From Papaya."* ■

Purple Color Signals Almond Contamination

A toxin in almonds can now be detected by a distinctive, fluorescent purple that shows up when the shelled nutmeats are exposed to ultraviolet light. The telltale color is unmistakable evidence of aflatoxins, highly toxic compounds that are produced by a mold. Toxin-free kernels show up as a fluorescent white, blue, or yellow.

The incidence of aflatoxins in almonds is very low, about one out of every 26,500 almonds. Almond producers, as well as state and federal agencies, regularly analyze random samples of raw and roasted almonds and almond products for the toxin.

The discovery of the link between the purple tint and the toxin paves the way for future development of electronic detectors, specially calibrated for safe, simple, and rapid recognition of the distinctive purple color in contaminated nuts.

Although such detectors might not be able to screen nuts that have their thin brown outer skin (pellicle) intact, these nuts are the least likely to contain any toxin. Electronic detectors are already used on production lines to sort out broken or otherwise damaged almonds. For technical information, contact John E. Schade, USDA-ARS Western Regional Research Center, 800 Buchanan, Albany, CA 94710. *Patent No. 4,535,248, "Method for Detecting Aflatoxin in Almonds."* ■

Debittering Citrus Juice With Cyclodextrin Polymers

See "Sugar Byproduct Removes Bitterness From Grapefruit Juice," p.4, for information on Patent Application Serial No. 526,753, "Method of Debittering Citrus Juice With Cyclodextrin Polymers."

How To Obtain a License for USDA Patents

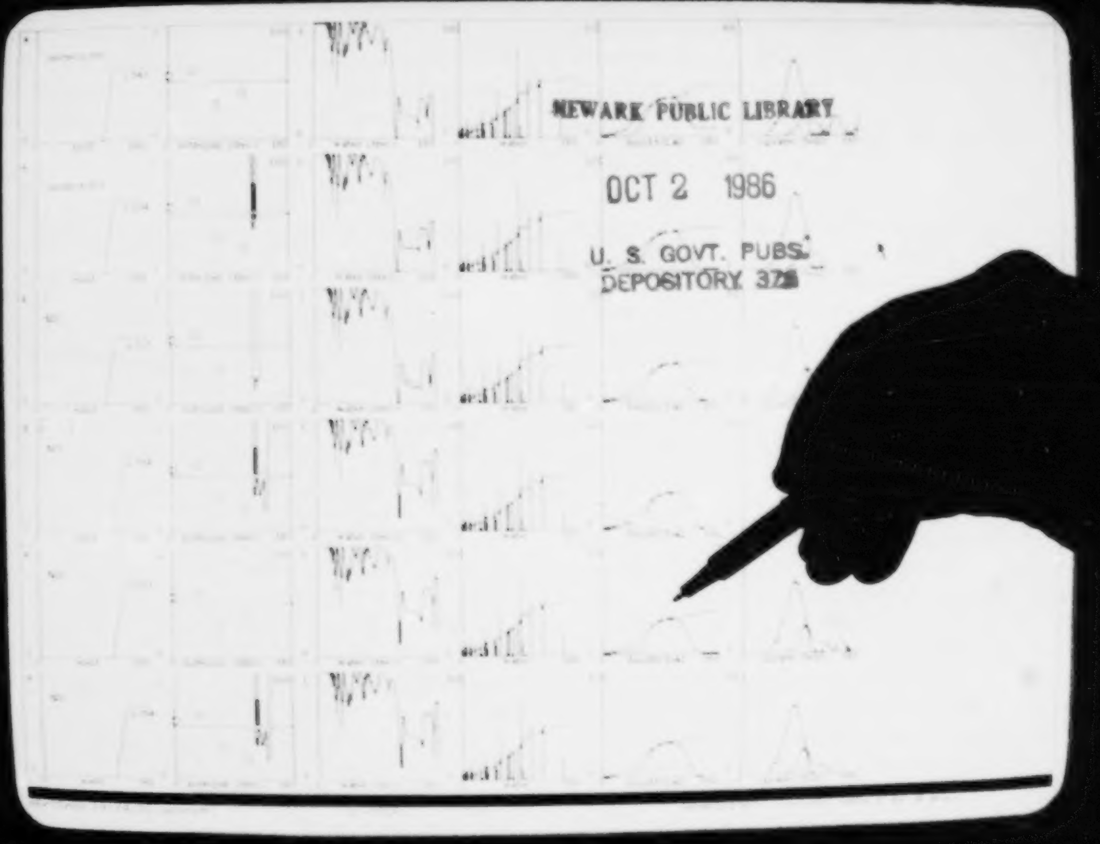
A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 8, September 1986

Agricultural Research

34/8



NEWARK PUBLIC LIBRARY
OCT 2 1986
U. S. GOVT. PUBS.
DEPOSITORY 378

```
06/23/86  14:04:56      COTTON MANAGEMENT EXPERT SYSTEM:

APPLY 40 POUNDS OF NITROGEN ON JULY 23, IF IT STAYS HOT AND DRY.
HARVEST-AID CHEMICALS MAY BE APPLIED ON SEPTEMBER 1.
YOUR YIELD WILL BE 2.754 BALES PER ACRE.
```

A77.12:

FORUM

The Great Cotton-Yield Mystery

There's something fascinating about cotton, a plant of persistent irony and a history seething with drama. It grew wild in both the Old World and the New, and it has been cultivated in both worlds since ancient times. It's a perennial but is cultivated as an annual. It's both a fiber and a food—cottonseed oil being the world's fifth most important edible oil and cottonseed meal a major feed for livestock. Cotton fiber was essential to the industrial revolution of northern Europe. Cotton figured as a major factor in the causes of the American Civil War that devastated the South, and it financed the South's economic recovery during Reconstruction. Invention of the cotton gin in 1793 made cotton the fiber of the masses.

From the end of World War II until the mid-1960's, the per acre productivity of cotton doubled in the United States, going from about half a bale per acre to a bale (a bale is about 500 pounds of cotton lint).

Then, mysteriously, while the yield per acre of virtually every crop in America was increasing by a percent or so annually, the yield of cotton not only failed to increase—it declined.

And yet there are at least a half dozen good reasons why cotton yields should have risen rather than fallen, especially: the introduction of higher yielding varieties, the elimination of poor quality cotton land from production, the squeezing out of weaker farmers by the economic crunch of low cotton prices, and better pest management.

Meanwhile, cotton has been subjected to overwhelming competition from synthetic fibers. Today, there are three bales of synthetics milled for every bale of cotton. Usage would be even more lopsided if it were not for the development, just after World War II, of a way to make cotton fabrics "wash and wear."

Agricultural Research Service scientists at the Southern Regional Research Center in New Orleans, LA, played a large role in that development as well as the latest improvement, known as durable press or permanent press. ARS scientists continue to search for ways to improve permanent-press treatments for cotton.

But people shopping for clothing always end up looking at the price tag. The synthetic fiber industry has recently adopted a vigorous strategy of research to produce fibers at still lower cost. For the cotton industry to survive, research to lower production costs is imperative. Yields are a good place to start, because if farmers can get more crop out of the same amount of land, with practically the same amount of inputs, the extra yield should increase net income.

One theory holds that the reason yields have declined is because cotton is so complex a plant it is particularly difficult to manage properly. Cotton has unique growing characteristics which are more complicated than those of most crops. For example, the cotton plant has only modest requirements for nitrogen during most of its growing season, but as it forms cotton bolls, the demand for nitrogen is intense.

If nitrogen is applied too early, or untimely rainfall occurs, the nitrogen may be leached from the soil before the plant needs it. If any nitrogen is left when the plant is finished making bolls, it will be used to grow taller plants with more leaves. Without additional cotton, this regrowth is nothing but a nuisance, interfering with the harvest.

Cotton management problems may be alleviated by an ARS-Mississippi State computer program that gives farmers expert advice. An industry group, The Cotton Foundation, is funding this work and also a study in which V.R. Reddy, an ARS plant physiologist at Mississippi State, will use the computer program to measure the roles various factors might play in the cotton yield mystery. Weather has already been eliminated as a cause. A computer comparison of weather patterns showed nothing that matches the decline in yields. Reddy will also look at air pollution in the form of ozone released from motor vehicle exhaust pipes and industrial smokestacks, soil compaction from heavy farm machinery, and management practices such as the rates and timing of herbicide and insecticide applications.

Perhaps part of the answer has been found unknowingly: U.S. Department of Agriculture estimates for 1984 and 1985 show record-high yields of 600 and 630 pounds per acre, respectively. No one is sure of the reason, just as no researcher has found a convincing reason for the prior years of decline.

But anyone who takes a look at how cotton yields have fluctuated over the past several decades can see that a great deal of effort by farmers and researchers working together will be needed to keep yields above 600 pounds per acre.

Hal E. Lemmon

Crop Simulation Research Unit, Agricultural Research Service, Mississippi State, MS

Agricultural Research

Computer monitor shows crop data generated by a cotton management expert system developed by ARS scientists in cooperation with Mississippi State University. Each horizontal row shows predicted yield and harvest date with various applications of fertilizer and irrigation water. Story begins on page 6. (0786X800-13)

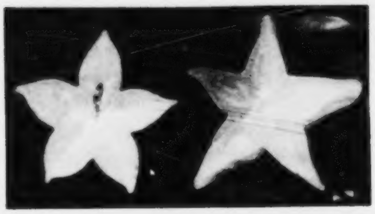
p. 9

6 When Comax Speaks, Farmers Listen

Yearly savings could run into the thousands of dollars per farm if this still-developing computerized expert system becomes widely available to cotton growers.

11 Strange Names, Fancy Flavors

If horticulturist Robert J. Knight has his way, many more subtropical fruits will be available to consumers in the years to come.



p. 12

DEPARTMENTS

4 AgNotes:

Grasshopper Virus: Possible Control Tactic
Pollen Put in Deep Freeze
Tomato Product Repels Grain Weevils
Iron and Aging: A Look at Ferritin

14 Technology:

Genes Found To Help Bacteria "Eat" Pesticides
TEKTRAN Offers Preview of ARS Research
Unshelled Walnuts OK for Export to Japan

16 Patents:

New Bacterium Fights Pythium Disease of Cucumbers, Peas
New Sensor Ensures Top Quality Cotton Fiber

p. 14

Vol. 34, No. 8
September 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Daniels
Art Director: Deborah Taylor

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Grasshopper Virus: Possible Control Tactic

Viruses that naturally infect some grasshoppers might be used to stop the destructive rampages that grasshoppers often go on.

"We are searching for a natural plague that we can spread around before grasshopper outbreaks occur. This would prevent the severe crop and range damage that happens every few years," says John E. Henry, an Agricultural Research Service entomologist in Bozeman, MT.

Hot and dry conditions in the West can upset a delicate balance in which natural diseases keep grasshopper numbers fairly stable. Grasshoppers thrive in dry weather and can reproduce faster than their natural diseases can infect them.

"During a typical grasshopper outbreak, six to 10 grasshopper types predominate. Each is slightly different and reacts to viruses in different ways.

Grasshopper feeds on wheat plant. Every few years, hot and dry weather in the West triggers grasshopper outbreaks that severely damage crops. (0779X981-18A)

Henry says an ideal virus, once introduced into the grasshopper population, would continue to infect later generations, perhaps requiring only one control effort that would last several years.

Because he hasn't found any sufficiently virulent viruses among the more than 600 grasshopper species in this country, he is now sorting and classifying those he has collected worldwide.

"Seven entomopox viruses look promising," he says. "They cause diseases in grasshoppers but not humans or livestock."

Henry says so far he has tested one entomopox virus on a 10-acre test plot and found results encouraging.

Chemical controls are quicker but can be expensive. "The 1985 infestation cost the federal government more than $26 million. We can expect the total bill, including state and private costs, to have been double that," says Henry.—By **Dennis Senft,** ARS.

John E. Henry is at the USDA-ARS Rangeland Insects Laboratory, Montana State University, South 11th Ave., Bozeman, MT 59717. ■

Pollen Put in Deep Freeze

Most people associate pollen with springtime wheezing and sneezing, but it is an essential element in the propagation of most types of plants, including food and feed grains.

And now researchers at USDA's Agricultural Research Service are chilling pollen from a protein-rich grain to give it a longer life than nature planned.

Normally, the pollen from pearl millet dies a few hours after being removed from the plant's flowers. But Wayne W. Hanna and two coresearchers at Tifton, GA, have kept the pollen alive in cold storage for over 4 years.

Hanna says storing pearl millet pollen longer saves the time and space needed to grow plants for pollen.

"It's like having a sperm bank to draw from to breed better varieties of pearl millet," says Hanna, a plant geneticist.

"Whenever we need pollen to fertilize other plants, we have a ready supply in the refrigerator or freezer," he says. "Before, we had to continually grow many plants for no reason other than having their pollen, and that was time-consuming and expensive."

Unfamiliar to most Americans, pearl millet is a plant of many uses, ranking among the world's important human staples and animal feeds. According to Hanna, it is grown as a food grain on 50 million acres in India and Africa. In Australia, South America, and the southern United States, it is a major summer livestock forage.

Because it tolerates drought better than other grains, U.S. ranchers increasingly see it as a potential feed grain in areas where irrigation water is neither as plentiful nor as cheap as it once was.

Hanna, geneticist Glenn W. Burton, and agronomist Warren G. Monson developed the pollen-storage technique.

In the new technique, pollen is harvested, dried, and stored in airtight containers. Best results were obtained by drying pollen to 6 or 7 percent moisture or less and storing it in a refrigerator at 40°F or in a freezer at 0°F.

Pollen with higher moisture of 7 to 8 percent has been preserved at -100°F, but that requires a special freezer.

Hanna says, "We hope that scientists working with other kinds of grass will find our techniques applicable, perhaps with modifications, to their breeding programs."—By **Sean Adams,** ARS.

Wayne W. Hanna, Glenn W. Burton, and Warren G. Monson are at the USDA-ARS Forage and Turf Research Laboratory, Georgia Coastal Plain Experiment Station, Tifton, GA 31793. ■

AGNOTES

Tomato Product Repels Grain Weevils

A natural product of the tomato plant may protect stored grain against some insects.

Chemist Karl J. Kramer and entomologist Richard W. Beeman, both with the Agricultural Research Service in Manhattan, KS, are testing 2-tridecanone, a chemical taken from the foliage of tomato plants. In one test, they applied various doses to wheat and then infested the wheat with eight species of stored-product insects.

The natural insecticide was most effective on granary, rice, and maize weevils—insects which insert their eggs into the grain kernel. It was not effective, however, on the other insects tested—the confused flour beetle, the red flour beetle, the lesser grain borer, the Indianmeal moth, and the almond moth. These insects place their eggs on the surface of the grain. "2-Tridecanone probably penetrates the wheat kernel, where it is more effective against insects that develop internally," says Kramer.

Kramer placed granary weevil eggs in jars of untreated wheat and in wheat treated with 200 parts per million 2-tridecanone. After 12 weeks, an average of only two young weevils developed per jar of treated wheat, as compared with an average of 357 weevils in each jar containing untreated wheat.

2-Tridecanone also proved to be a weevil repellant. In jars of both treated and untreated wheat, granary weevils could "escape" by crawling into probe traps. After 183 hours, half the weevils were trapped in untreated wheat, while only 18 hours elapsed before 50 percent crawled into the probes in wheat treated with 500 parts per million 2-tridecanone.

The chemical first came to Kramer's attention when George Kennedy, an entomologist at North Carolina State University, reported in 1980 that it was toxic to certain plant-eating insects. It is but one of several possible new treatments for stored grain that Kramer is testing.—By **Linda Cooke-Stinson,** ARS.

Karl J. Kramer is in USDA-ARS Biological Research at the U.S. Grain Marketing Research Laboratory, 1515 College Avenue, Manhattan, KS 66502.

Iron and Aging: A Look at Ferritin

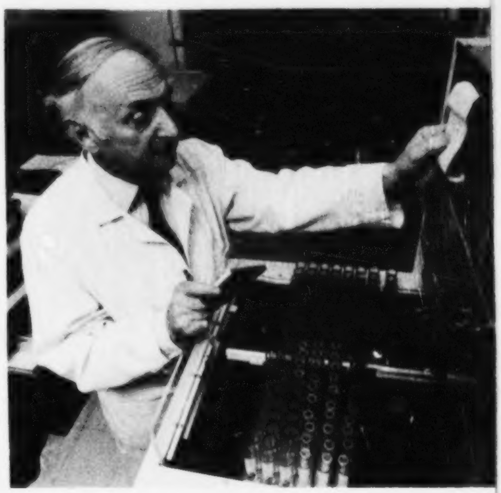
Research at ARS' Human Nutrition Research Center on Aging at Tufts is probing one theory of aging and turning up some intriguing findings. This widely studied theory holds that aging is due to the oxidation of cell membranes—the gatekeepers and structural framework of cells.

One cause of oxidation, says Hamish Munro, senior scientist at the Boston center, may be too much free iron in the body's cells. Although iron is an essential mineral, an excess could lead to the destruction of cell membranes by oxidizing their fatty components. Normally, cells protect themselves by producing ferritin—a protein that locks up the iron until it is needed.

The theory is far from ironclad, however. Munro and colleagues want to determine if the aging process is accelerated or controlled by iron that isn't locked up in ferritin. One question, he says, is whether "as we get older our capacity to make ferritin decreases, or does ferritin cease to do its job properly?"

Munro and colleagues at the Boston center have cloned the gene that contains the blueprint for ferritin. They found that ferritin is composed of 24 subunits that come together to form a shape "like a practice golf ball," he says. Free iron passes through the holes and is trapped inside.

While working with a team from the Massachusetts Institute of Technology, Munro discovered that although the gene dispatches the message to assemble ferritin, the messenger "sits around until it is called into action by iron." The messenger is RNA copied from the code in the DNA. There are only a few instances known in which messenger RNA is latent, Munro says. "This is the first one found to be activated by a known signal."



Hamish Munro, senior scientist at the USDA-ARS Human Nutrition Research Center on Aging at Tufts University in Boston, MA. (1082X1209-3)

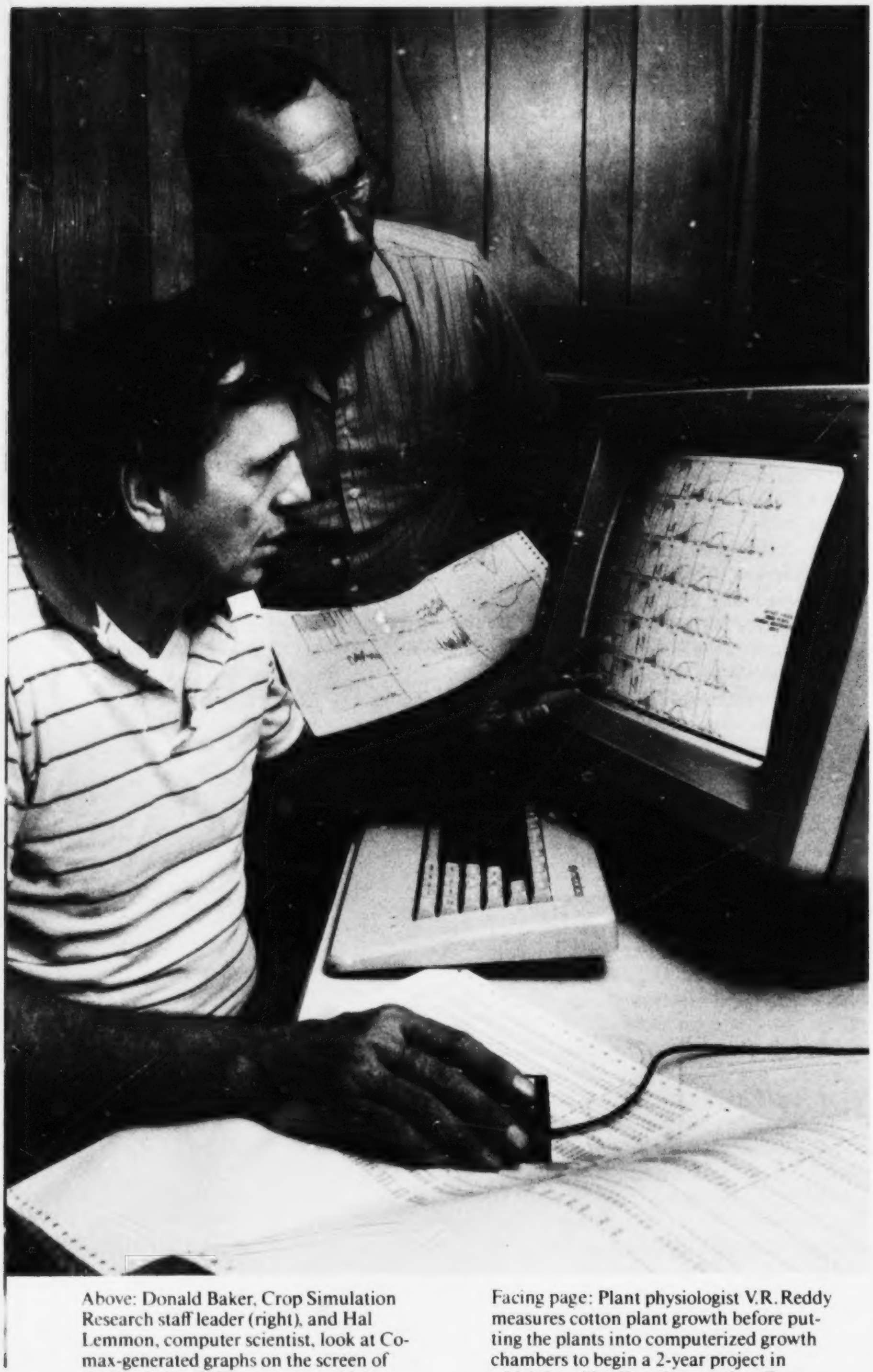
Iron activates messenger RNA to assemble ferritin, and Munro believes his team has clues to the identity of the segment of the messenger RNA that acts as the switch. The segment is located near the start of the code for ferritin, he says, "just where you'd expect to find a regulator."

To confirm that the segment is the switch, Munro is making artificial segments in the lab and attaching them to messenger RNA's for other proteins. If iron activates the production of these proteins, he says, "we will know that the segment is indeed sensitive to iron."

With the ferritin machinery virtually decoded, Munro says he is feeding iron-rich diets to laboratory animals to see if their ferritin production keeps pace with the toxic levels of iron as they age.—By **Judy McBride,** ARS.

Hamish Munro is at the USDA-ARS Human Nutrition Research Center on Aging, 711 Washington Street, Boston, MA 02111. ■

When Comax Speaks, Farmers Listen



Above: Donald Baker, Crop Simulation Research staff leader (right), and Hal Lemmon, computer scientist, look at Comax-generated graphs on the screen of the Symbolics 3670 computer, which Lemmon used to write the Comax program. (0786X798-14)

Facing page: Plant physiologist V.R. Reddy measures cotton plant growth before putting the plants into computerized growth chambers to begin a 2-year project in which he will collect data on the effects of a commonly used cotton growth regulator. Data will be fed into Comax to expand its scope. (0786X789-18)

Mississippi cotton farmer Frank M. Mitchener lost hundreds of thousands of dollars worth of cotton in a bet against a computer 2 years ago, but he won't let it happen again.

In 1984, Mitchener, who farms several thousand acres of Mississippi Delta cotton land in Sumner, MS, began testing a computer model that predicts cotton yields. USDA's Agricultural Research Service conducted the test in cooperation with the National Cotton Council. The model is called Gossym, a hybrid term formed by combining *Gossypium*, the plant genus cotton belongs to, with "simulation."

Mitchener had scheduled a family vacation for the first 2 weeks in September, a time he decided would be that coveted pause before a hectic harvest. Like other cotton farmers, he made his decision on when to harvest by a 60-percent boll-open rule of thumb.

Cotton bolls are the fruit of the plant that contain the seeds with their attached cotton lint. To tell when the cotton is mature enough to harvest, farmers look at sample plants and count how many bolls have dried and cracked open.

When they find that at least 60 percent have opened, they prepare for harvest. This involves applying chemicals that stop growth, pop bolls open, and cause leaves to fall off, allowing the mechanical pickers easy access to the bolls. Then the race to harvest begins. The pressure is on because the fall brings rain that can turn fields into Mississippi mud traps, knock cotton out of the bolls, lower cotton weight by washing the wax off, and create moist homes for fungi that weaken and change the cotton to a less valuable off-white color.

What Mitchener would like to have is more time to harvest before the rains come. And that's what the computer tried to tell him he had...the computer told him to spray his defoliants on September 1 and begin harvesting. Mitchener was darned if a computer was going to defy the 60-percent rule and ruin his vacation plans too.

Mitchener returned from vacation on September 14 and began defoliating on September 21, the day after he counted 60 percent of the bolls cracked open on several plants. He started harvesting 10 days later.

He got only 675 acres harvested before the rains began on October 6. "Twenty inches of rain fell in October with little cotton harvested again until November," Mitchener says. "Had I listened to the computer and started on September 1, I could have begun harvesting on September 13 and been finished before October 6. Normally, I harvest 1,100 pounds an acre of good quality cotton. As it turned out, I lost about 200 pounds per acre (that fell to the ground) and probably 12 cents a pound in quality."

> ***"We learned how important the ability to predict mature bolls is to cotton farmers."***
>
> —**James M. McKinion,** crop simulation researcher

Cotton experts had long known that cotton bolls are mature 2 or 3 weeks before they're dry enough to crack open, but they never knew a farmer's livelihood depended so heavily on that knowledge. "That's one benefit of us working so closely with farmers on a program like this: We learned how important the ability to predict mature bolls is to cotton farmers," says James M. McKinion, an electronics engineer who is part of the ARS Crop Simulation Research team at Mississippi State University. "That turned out to be the biggest value of the program to Mitchener."

Mitchener's computer is linked by telephone line to a solar- and battery-powered weather station in one of his fields. The weather station collects information on air temperature, rainfall, and solar radiation.

The computer model's intimate knowledge of the daily lives of cotton plants came from data collected since 1974 in bubble-top containers developed in South Carolina in collaboration with Clemson University. Now located at Mississippi State, these outdoor chambers are wired to computers inside the research buildings. The computers sense and control the temperature, soil moisture, and carbon dioxide concentration in the chamber's atmosphere.

The scientists made daily observations of the plants growing in the chambers. They fed this data into the computers, along with measurements taken by removing some plants and analyzing them for weight and contents.

To tailor the model for each farm, the scientists need only add specific soil data and the varieties that will be planted. Then the weather station becomes the driving force for the model, giving it the daily information it needs to make predictions based on past experience.

Owning a $5,000 weather station isn't essential. If the model is ever widely used, some farmers may decide to share a weather station centrally located at the local cotton gin. By necessity these farmers already cluster in "gin communities" no more than 15 miles from a gin so, except for rainfall data, the weather information should be applicable to their farms.

But in 1984, the year Mitchener and Sam McCoy, a South Carolina cotton farmer, began the test—sponsored by Union Carbide Corp. through the National Cotton Council—even one gin community would have been more than McKinion and his colleagues could have handled. As McKinion puts it, "We had our hands full helping two farmers run and interpret this complex research model. We're just 7 scientists and 3 technicians, and we can't work that closely with even a fraction of the nation's 30,000 cotton farmers."

This team—which developed the latest version of the model over a 12-year period, from 1973 to 1984, in cooperation with Mississippi State University, Clemson University, and the Hebrew University of Jerusalem, Israel—knew that help was in sight because they had been chosen as one of three ARS teams to test the application of a $120,000 Symbolics 3670 computer to agricultural problems. The other teams are at Cornell University in Ithaca, NY, and at the ARS center in Beltsville, MD.

The Symbolics 3670 had recently entered the marketplace as a smaller and less expensive version of the multimillion dollar supercomputers used with artificial intelligence systems in military, aerospace, and university research. Unlike the typical personal computer, it deals with words and other symbols, rather than numbers.

This new tool gave Hal E. Lemmon, a scientist on the Crop Simulation Research team, the power to write a computer program that mimics the thinking of human experts when restricted to a limited area of knowledge. And he did it in 7 months.

The program, called Comax (COtton MAnagement eXpert), runs Gossym for the farmer and takes the place of scientists in interpreting the numerical data churned out by the model.

The great thing about this program is that although it was written on a $120,000 machine, it can be copied onto a diskette and used on the current generation of IBM personal computer, the PC-AT, or equivalent machine, beefed up with extra memory. At today's prices, users would pay $4,000 to $7,000 for the computer and related equipment. Of course, by the time this program is ready for commercial use, even more powerful machines may be available at the same price.

The expert system developed at Mississippi State revolves around a set of "If-Then rules such as: "If the crop suffered stress from nitrogen

Mitchener (left) and McKinion check automated weather station which feeds daily weather information into Mitchener's farm computer to be used to update its cotton yield and harvest date predictions. (0786X791-28)

deprivation on July 20 in the last simulation, then see what happens if 40 pounds of nitrogen were to be applied on July 10." The computer keeps trying different amounts and dates to see which will prevent a yield-robbing nitrogen stress. When it finds the best combination to prevent this, it recommends that action to the farmer.

During the 1985 season, the crop simulation team used Comax/Gossym on their computers and gave Mitchener and McCoy the results. The farmers had only the cotton growth model, without the expert system to run the model for them.

The 1986 season is a different story. Both have a version of Comax that runs on their computers. And 20 other cotton farmers from across the Cotton Belt, including Mitchener's neighbor Kenneth B. Hood, have joined the test.

Hood's cotton season has gotten off to a different start this year because of the program. Take June 10, for example. That's the date he used to routinely apply nitrogen fertilizer at the rate of 50 pounds per acre. Not this year.

At 3:30 that morning, Hood was in his office, centrally located on the land he and his brothers farm, asking his computer to call the weather station and update its files to include a heavy rainstorm that happened the previous day. Hood leaves the computer running 24 hours a day and can add the previous day's weather to the files after midnight each day.

Hood wants to know how the 2 inches of rain will affect the nitrogen fertilizer he applied before planting in April. Will it wash so much of it away that his plants will go into nitrogen stress soon? Will he need to apply more, how much, when?

The computer asks him if he wants to simulate an entire growing season, starting from the date of emergence of the cotton he planted on April 7, or later. Hood types in June 10. The computer monitor's screen shows several optional weather scenarios for the rest of the season. Hood chooses to assume the weather will be mainly hot and dry.

The computer tells Hood he's in good shape. He won't need to apply any more fertilizer for over a month if the weather does stay hot and dry. That answer is backed by a graph showing his plants won't need more nitrogen until July 23. The computer also prints five other graphs showing: past nitrogen applications, rainfall, predicted water stress, plant growth (height, number of flower buds, number of bolls), and predicted yields. All of the graphs, except for the one with yields, show the plants' responses on a daily basis throughout the normal 160-day growing season.

"Before this, it was all guesswork and habit. I'd automatically apply 50 pounds of nitrogen every June 10, without knowing when or how much was actually needed. With cotton prices at 55 cents a pound and promising to get lower, we need to take some of the guesswork out or we'll all be out of business. It'll make us better farmers, help us make better, more timely decisions. That's the name of the game. I'm trying this on 600 acres of the DPL 50 cotton variety and 200 acres of Acala 90. If it works, I'll use it on my entire farm next year," Hood says.

Hood is carefully examining his cotton, recording details such as the number of flower buds. He needs this data to be sure the plants in the field look the same as the plant image in the computer. For each cotton variety, the computer, on a daily basis, can draw a picture of the cotton plant to show how it sees the plant developing.

Graphs Replace Mind-Boggling Numbers

The ability of the computer to print information in the form of graphs, in addition to words, is a very important part of Comax. Information, such as the period when the plant will undergo stress, stands out at a glance, a far cry from what was available in 1984. Back then, Mitchener got the model's calculations in "a series of columns of hundreds of numbers, more than the brain could comprehend."

And the time it took Mitchener to run the model himself limited its usefulness to him. "It took from 1½ to 2 hours to run a simulation. And you had to simulate the entire season every time you changed something. When I tried to consider different alternatives—playing what I call the 'What-If' game—I couldn't afford to try too many variables. To save time, I made decisions without considering everything."

Comax makes the runs for farmers, playing the "What-If" game for them, while they sleep.

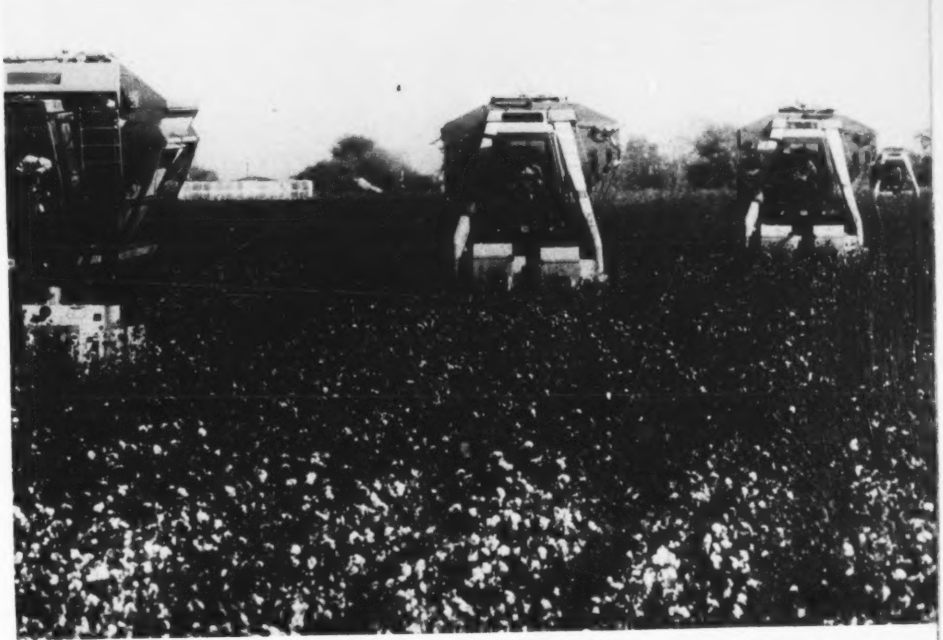
When run on an IBM PC-AT or equivalent personal computer, it can simulate an entire season in 20 to 30 minutes. As it tries different scenarios, it can save even more time by restarting later in the simulated season, from the date of the latest change.

Farmers can ask for an explanation of how the computer arrived at its decision, so they can judge its wisdom.

This ability to explain itself gives Mitchener and other farmers confidence in the computer. Had the model been smart enough to defend its recommendation for an early harvest in 1984, Mitchener says he would have listened to it.

By last year, Mitchener was more of a believer, so much so that when the computer told him to break another longstanding rule of cotton farming he did it almost without blinking and he did it on every one of his several thousand acres instead of just the test plot.

That season the computer told him to apply 30 pounds of nitrogen fertilizer in late July. Cotton farmers worry about fertilizing after June 30 because they know it might cause a regrowth. Mitchener sometimes applies fertilizer early in July, but never later on, so close to the time he intends to apply defoliants and boll-openers to stop plant growth.


Comax tells cotton farmers when the plants are mature enough to harvest. (067-7-36)

The cotton model predicted that Mitchener's plants would go into nitrogen stress in August if he didn't apply nitrogen in mid-July.

The model can anticipate nitrogen stress long before it occurs and causes visible damage. "I would never have seen that my cotton needed more fertilizer until August, and then it would have been too late to put it on," Mitchener says.

Mitchener may be a believer but he can't afford to be a blind follower. He hedged his bets a little, cutting the recommendation down to 20 pounds per acre for his farm. He did apply the recommended 30 pounds to half of the 16 rows in his test plot, leaving every other row unfertilized, for comparison. The eight fertilized test rows yielded $60 more cotton per acre, after costs, than the unfertilized rows.

The computer may very well have been correct about the plants being able to use 30 pounds of nitrogen per acre, but the increase in yield may not have been enough to justify the expense and risk of applying that much fertilizer.

Mitchener examines cotton plants to see if they are developing at the pace predicted by Comax, the computer program he is testing. (0786X805-7)

Mitchener had already applied a total of 140 pounds per acre to his fields and he couldn't accept the risk of raising that to 170, so much more than he had ever applied.

To make sure the recommendations are cost-effective, the crop simulation researchers are adding a computerized economics package that will calculate the costs of fertilizers and other inputs and compare them to the value of the yield.

At his farm office in Sumner, MS, Frank Mitchener (center) looks over data from the Comax (COtton MAnagement eXpert) computer program with James McKinion, an ARS electronics engineer. Mitchener's assistant, Mylinda Cail, prepares to enter instructions for Comax. (0786X793-20)

Besides information on nitrogen applications and harvest dates, the computer program also gives advice on irrigation. And it considers all these decisions in combination, accounting for interactions that affect yields.

Just as the computer anticipated nitrogen stress for Mitchener, it can anticipate water deprivation before any wilting is visible. Farmers will know weeks ahead of time that if there isn't a rain, the plants will start suffering damage on a certain day. In the past, a farmer would see the plants begin to wilt and then decide to turn the irrigation pumps on. Typically, the decision would be made one day and irrigation start the next.

For those who irrigate, McKinion envisions a day when Comax will not only make recommendations but actually carry them out. "It can be used to turn irrigation systems on and off whenever it decides. In addition, it could operate equipment that will mix herbicides, insecticides, and other chemicals into the irrigation water, deciding what, when, and how much to add."

The crop simulation team plans to expand Comax to include many other features, including models for the control of insects, weeds, and diseases. Entomologist Robert E. Fye has already begun developing the insects model, which will give farmers recommendations on insecticide applications.

Fye is collecting data on a dozen major insect pests and beneficial insects raised in eight computerized chambers. Currently, he is studying bollworms, a lygus bug, and a spotted mite. This summer he is feeding them bits of cotton plants to see how much and how fast the insects eat.

He is also finding out how quickly the insects develop at different temperatures. When all this information is in the computers, farmers can use it to know when and if to spray or whether they will have enough beneficial insects to do the job.

The National Cotton Council, a nonprofit association which represents the entire cotton industry from farm to textile mill, has investigated the possibility of starting a computerized telecommunications network that, as an extra benefit, would make Comax available to any Cotton Council member. The network would enable farmers to communicate by electronic mail with everybody else in the cotton business, as well as government agencies such as USDA's Agricultural Stabilization and Conservation Service.

A 1984 survey by the Cotton Council showed that 23 percent of their cotton farmers had computers, most with telephone linkups. The Council estimates that the share of member farmers with computers rose to a third in 1985.

Andrew G. Jordan, Director of Technical Services for The Cotton Foundation, a sister association of the Cotton Council, says the Council and the Foundation will begin a pilot test of the electronic mail network in September 1986, with participants from "every area of the Cotton Belt."

Jordan is very excited by both the network and Comax. He compares the possible dramatic changes in cotton farming with the types of changes Cyrus H. McCormick's reaper brought to wheat farmers and the tractor brought to all farmers.

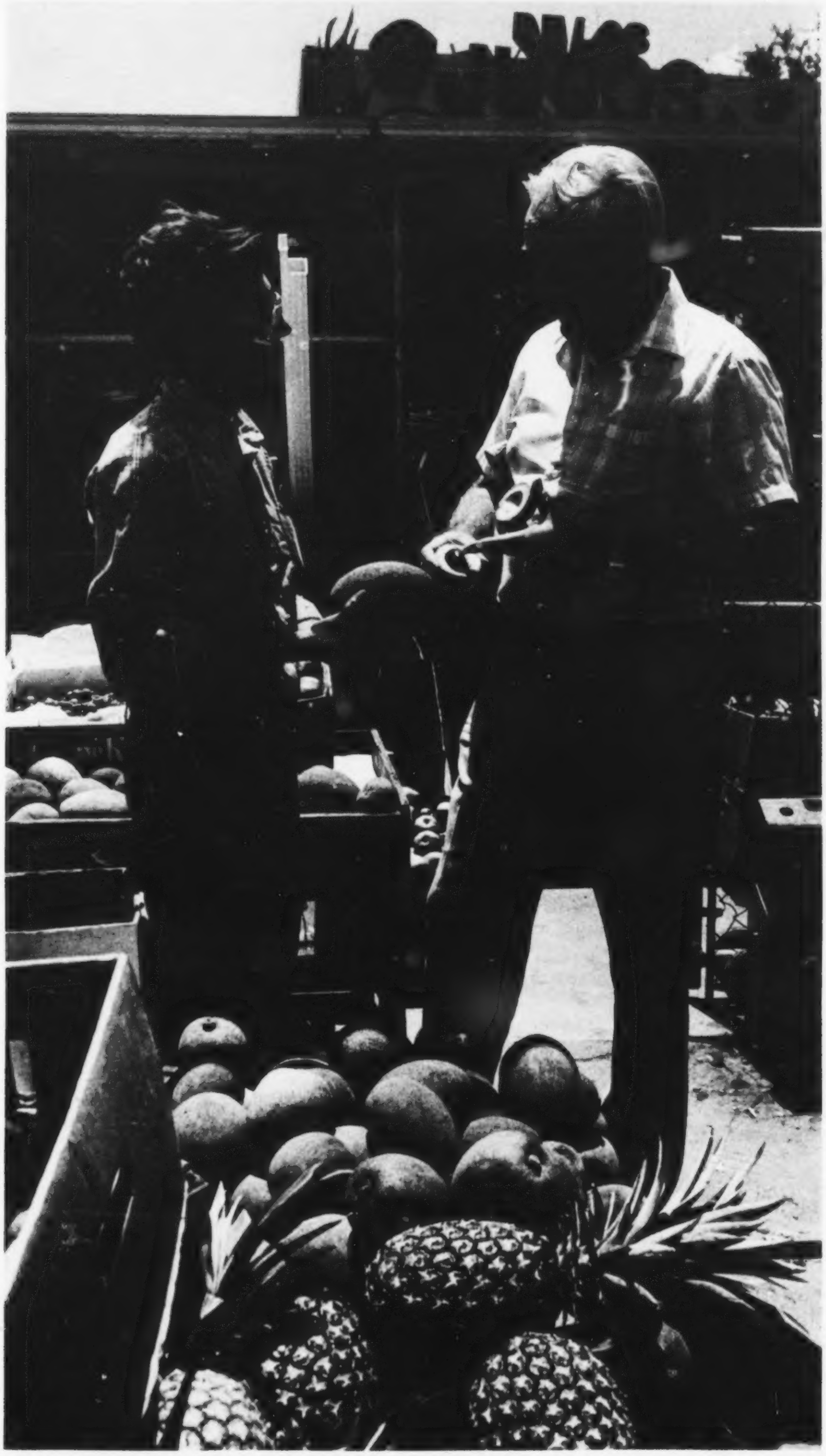
But Jordan is a level-headed businessman, and he balances the excitement with caveats about Comax. "Anything this new and exciting gets a lot of hype. We chose to spend more than $500,000 in aid to this project because we saw it as something useful that needed a financial boost to get it off the research workbench and onto the farm. We think it will allow farmers to make better decisions. But it's still just one more tool to help make farmers more competitive in the world market. We're not recommending farmers follow it blindly."

Nor would Baker. "The model Comax uses is more than 12 years old. Parts of it need updating. New cotton varieties have come on the scene, along with new compounds for cotton growers—such as new harvest-aid chemicals. Also, we need to expand Comax to respond to insect damage. There's a great deal that needs to be done over the next few years.

"On the other hand, we've seen that growers can reap some economic benefits from it right now. Despite the fact that we've got a lot of work left to do on it, we're already beginning to see some payoffs."—By **Don Comis,** ARS.

Donald N. Baker, Hal E. Lemmon, and James M. McKinion are in USDA-ARS Crop Simulation Research, P.O. Box 5367, Mississippi State, MS 39762. ■

Strange Names, Fancy Flavors



Horticulturist Robert Knight discusses fine points of mamey, a Cuban fruit, with employee of roadside fruit stand in Miami. (0786X884-7)

Exotic fruits with names like mamey, carambola, and lychee may someday become everyday items in your neighborhood grocer's produce section, thanks to Agricultural Research Service scientists at Miami, FL.

Indeed, who could resist a fruit like the carambola, a member of the wood sorrel family, whose sides are so deeply indented that it slices into sections resembling five-pointed stars? Besides its eye-catching shape and mild flavor, the carambola is attractive for nutritional reasons: It's a good source of vitamins A and C.

ARS horticulturist Robert J. Knight believes it has a bright future with consumers. He says, "I can see carambola really catching on in this country, because it's tasty and fairly adaptable to our climate, so it's easy to grow here."

"I can see carambola really catching on in this country, because it's tasty and fairly adaptable to our climate."

—Horticulturist **Robert J. Knight**

In fact, growers in Florida are devoting more and more of their land to carambola orchards. "Right now, we probably have about three times more acreage in carambola than we had just a few years ago," says Knight. "Plus, there are a great many areas in Florida which have just been planted, and those trees should begin to produce within 3 to 5 years."

Unlike most fruits, which have only one season, the carambola produces fruit twice and sometimes three times in a single year.

Knight attributes the growing popularity of some subtropical and tropical fruit partially to an increase in the immigrant population; for example, Southeast Asians in California and Latin Americans in south Florida. Tropical fruit is often an important and familiar part of their traditional cuisine. Mamey, for instance, a large ruddy fruit which tastes somewhat like sweet potato, is considered the national fruit of Cuba. And the lychee, a bright red sweet fruit about the size of a plum, has long been popular with the Chinese.

These are but a few of the many subtropical and tropical fruit crops being studied by Knight and other scientists at the USDA-ARS Subtropical Horticulture Research Station.

The first step in finding a new fruit crop is finding and importing the germplasm. Germplasm is the living cellular material containing the genetic blueprint of chromosomes for that particular plant. Knight's germplasm samples may be bits of plant tissue, seeds, or whatever is available.

When considering a new fruit, Knight asks: Is this fruit any better than the varieties we now have? Does it produce fruit well and regularly? Is it nutritious? Can it be economically grown here?

Port of Entry for New Crops

USDA's Subtropical Horticulture Research Station at Miami, FL, is one of eight stations where plants from all over the world are evaluated in search of new crops for the United States. First established in 1898 on 6 acres of land, the station has since grown to 210 acres, and over 20,000 plant introductions have been cataloged.

The station houses the Clonal Germplasm Repository, a collection of about 8,500 tropical and subtropical fruit, nut, and ornamental plants. Under the direction of curator Edward J. Garvey, plant material is provided to researchers, botanical gardeners, and commercial nurseries. Since 1933, when records were started there, more than 87,000 requests for plant material have been filled.

This is also the National Clonal Germplasm Repository for mangoes, coffee, avocados, bananas, plantains (a banana relative), subtropical jujubes (a date-like fruit), and sugarcane—which means the station is responsible for maintaining samples of up to 250 varieties of each crop, plus wild species.—C.L. ■

Candidates for U.S. crops are first evaluated for their ability to adapt to the southern United States. They are exposed to freezing temperatures, insects and disease, and adverse soil conditions. Knight next grows a large seedling population using the hardiest samples and then crossbreeds among these plants to develop new varieties.

Says Knight, "One thing we must always keep in mind: Horticulture is a matter of working with the environment. Plants are genetically programmed to respond to certain environmental conditions, and they must have those conditions for the most favorable growth. The best that we can hope for is to modify some plants so that they can be grown over a larger area—however, this certainly doesn't work with every plant."

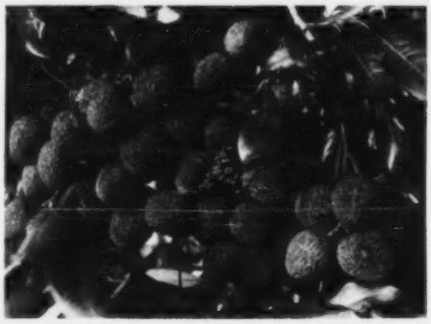
Often, a fruit can be improved by crossing two members of the same family. A classic example is the atemoya. In 1907, P.J. Wester of USDA, who was stationed in Miami for many years, was working on improving the cherimoya, a fruit usually grown in Peru, Chile, Bolivia, and Ecuador.

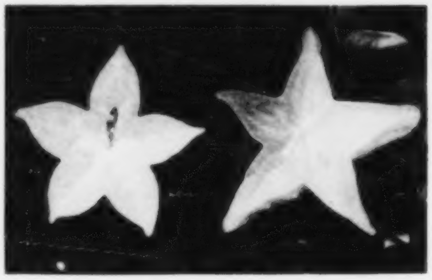
The cherimoya, one member of the family collectively called the "custard apple," and related to the American pawpaw, is a large green fruit with sweet, aromatic pulp and smooth, dark seeds. Since the cherimoya would ordinarily be grown in the mountains, it wasn't too successfully produced in Florida. Its poor relation, the sugar-apple, or anon, was better adapted to warm, sea-level conditions but was smaller and not as pleasantly aromatic.

> ***"We're hoping to produce a passion fruit which can be grown as far north as Virginia and Maryland."***
>
> —Horticulturist **Robert J. Knight**

So Wester crossed the cherimoya with the sugar-apple and came up with the atemoya, which grows very well at sea level, has a lot of vigor, and produces delicious fruit.

Wester's atemoya was the first of its kind; since then, even better varieties of the hybrid have been developed.





Top: Marc Ellenby of J.R. Brooks and Sons examines an atemoya in his private orchard. This hybrid of the cherimoya and anon (sugar-apple) was originally developed by ARS. (0786X896-10)

Center: Bright red lychee fruit originated in Southeast Asia but is gaining popularity in the southern United States. (0786X886-6)

Bottom: Two varieties of star-shaped carambola being developed by ARS. Plumper fruit with shorter "spikes" is better suited for shipping. (0786X883-21A)

Packers prepare carambola for shipping at J.R. Brooks and Sons, a Florida-based fruit grower and distributor. (0786X898-6)

Many improved fruits have been developed at the Subtropical Horticulture Research Station since Wester's atemoya. Some are still in the testing stage, such as a new passion fruit which is a cross between the yellow and purple tropical variety from Brazil and a subtropical variety from Maryland. "The hybrids we produced are more resistant to cold—a characteristic they get from the Maryland species—because of their ability to form new shoots from underground roots or rhizomes. But they still lack the superior fruit of the Brazilian species," says Knight.

"We're hoping to produce a passion fruit which can be grown as far north as Virginia and Maryland and still have the high quality and flavor of the Brazilian species."

Why are consumers still finding that many tropical fruits are expensive?

According to William C. Schaefer, marketing director for J.R. Brooks and Sons, a Florida-based fruit grower and shipper, it's partly because tropical fruit requires extra special care to keep it fresh and damage-free. Says Schaefer, "We use a lot of hand labor to prepare the fruit for shipping—treating it to prevent spoilage, using special packing materials—whatever's necessary for the fruit to arrive at peak quality." Besides the high labor costs, the rarer tropical fruits like lychee and mamey are still grown in relatively small quantities, which makes them something of a novelty in grocery stores.

William H. Krome, a Dade County fruit grower who bought his first avocado grove in 1929, agrees that some of the low-volume fruits can turn out to be moneymakers.

Krome specializes in avocados and limes but says mangoes provide the best return right now. He has also planted a few trees of lychee and mamey, "just to see how well they do."

Krome feels that the tropical fruit industry will continue to grow in this country as more and more people become aware of the variety of fruits available.

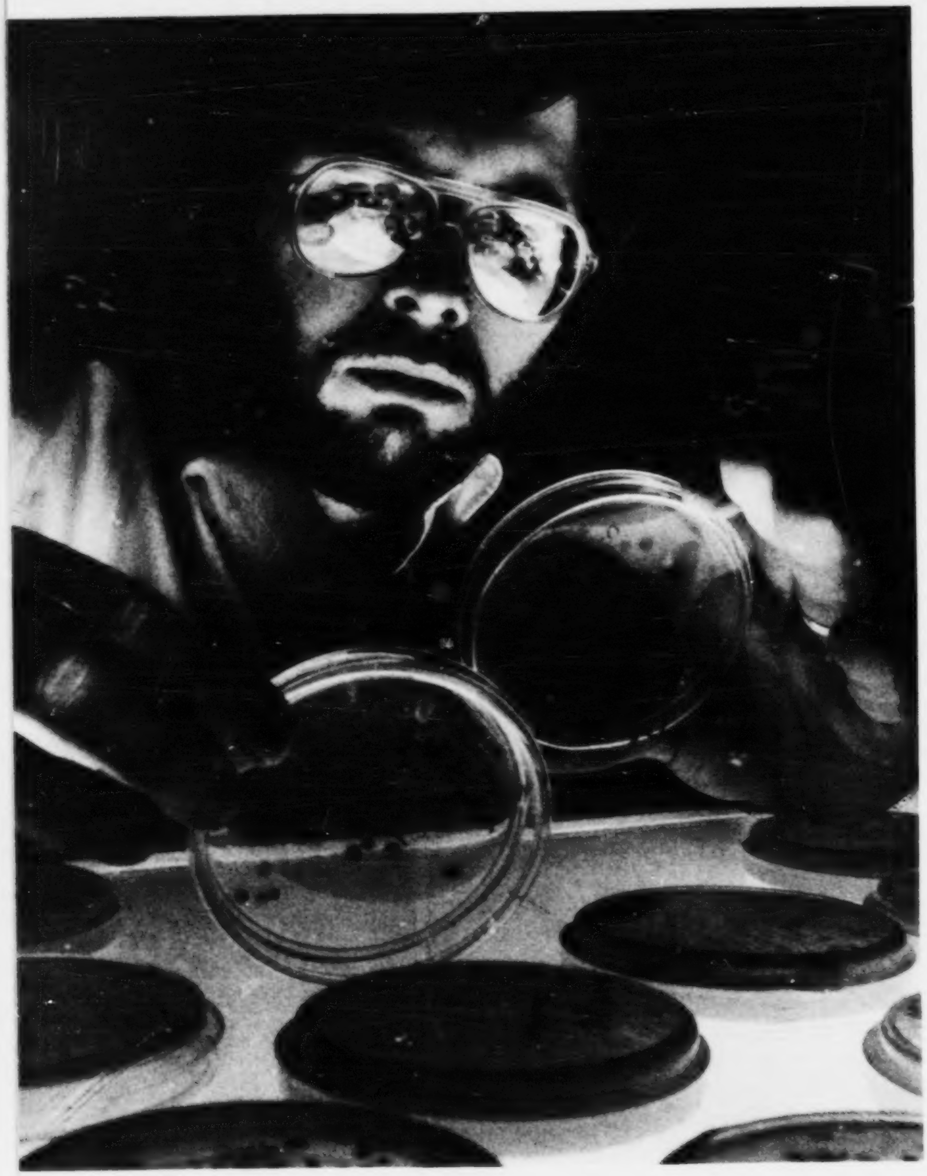
Educating consumers about the new fruits is one of Schaefer's biggest tasks. He says that J.R. Brooks and Sons uses a number of avenues for publicity, including advertising, news releases, visits to food editors, and in-store demonstrations. They send trained personnel into supermarkets to give out free samples of fruit, armed with nutrition information, recipes, growing tips, and so forth. "The in-store demos are relatively productive," says Schaefer. "They're a good way to get people to try different fruits."

"The bottom line," says Knight, "is to broaden the base of U.S. agriculture, by breeding new plants and improving the varieties we already have; to cooperate with U.S.-sponsored agricultural programs, such as exchanges of plant material and technical information with various foreign countries; and ultimately to offer American consumers a wider range of food choices."—By **Caree Lawrence,** ARS.

Robert J. Knight is at the USDA-ARS Subtropical Horticulture Research Station, 13601 Old Cutler Road, Miami, FL 33158. ■

TECHNOLOGY

Genes Found to Help Bacteria "Eat" Pesticides



Microbiologist Jeffrey Karns checks petri dishes in which he grows pesticide-degrading bacteria. (0386X501-35)

Two soil bacteria have been found that can be genetically altered to help speed the breakdown of pesticides, says microbiologist Jeffrey S. Karns of the Agricultural Research Service.

"We have identified genes that cause enzymes to degrade certain pesticides," says Karns. "Now, we are cloning the genes so that the bacteria make a lot more enzymes for better toxic waste disposal, especially on farms."

Agency research on pesticide-degrading bacteria is aimed toward an environmentally sound way to dispose of pesticides.

One of the bacteria in Karns' studies, *Achromobacter*, fully degrades carbofuran, a pesticide used against corn rootworm and other crop insects, in a matter of hours. Another, *Flavobacterium*, partially degrades coumaphos, used to kill insect pests of livestock, in about 36 hours. Complete degradation takes another day of treatment using ultraviolet light and ozone.

"These are potent insecticides. The bacteria can substantially reduce their presence on farms by degrading them quickly, before they can seep into the soil," Karns says.

Farmers commonly dispose of excess pesticides from spray tanks in soil pits that are lined with concrete or plastic. Microbes in the pits at least partially degrade the wastes to less toxic materials. However, the process is slow—taking from several weeks to a year—and leaking pits can allow liquids to seep into groundwater.

Karns and his colleagues at the ARS laboratory in Beltsville, MD, will continue to search for other pesticide-eating bacteria that can be genetically engineered to hasten the decomposing of pesticides.

Karns uses a DNA-cloning technique to isolate the genes from the bacteria. He first inserts the enzyme-making genes into plasmids, which are free-floating, replicating circles of DNA in bacteria. Then, he chemically cuts the plasmid, splices in the gene he wants to study, and tests the new gene for the ability to break down a pesticide.—By **Dvora Aksler,** ARS.

Jeffrey S. Karns is at the USDA-ARS Pesticide Degradation Laboratory, Bldg. 050, Beltsville Agricultural Research Center, Beltsville, MD 20705. ■

TEKTRAN Offers Preview of ARS Research

Over 6,000 brief, easy to read summaries of the latest research on genetic engineering, safeguarding crops and animals from diseases, biological control of pests, human nutrition, and other fields are available on a new computer information service provided by USDA's Agricultural Research Service.

Known as TEKTRAN, for *Technology Transfer Automated Retrieval System*, it offers notice of research results which have been peer-reviewed and cleared by ARS management. About 300 new findings are entered into the database each month.

ARS is offering—on a first-come, first-served basis—an opportunity for a limited number of interested organizations with computers and telephone modems to have direct access to TEKTRAN. There is no cost for using the database. However, users are responsible for their own telephone charges.

Each entry on the database includes a brief summary describing the research but does not reveal specific details that would preclude patenting or publication. TEKTRAN also provides the name, address, and phone number of ARS scientists involved in the research.

Computer searches can be made in several categories. Among these are: Keyword, Multiple Keywords, Scientist's Name, and Commodity. The file can be accessed by specific dates in addition to the search categories indicated above. A user could enter the system once a month, for example, to search for new entries on a specific topic without having to look at the entire database each time.

Additional information on the procedure necessary to obtain access to this new database can be obtained by contacting: *James T. Hall, National Technology Transfer Coordinator, USDA-ARS, Room 403, Building 005, BARC-West, Beltsville, MD 20705. Telephone (301) 344-4045.* ■

Unshelled Walnuts OK for Export to Japan

U.S. walnuts still in the shell can be sold to Japan, now that USDA Agricultural Research Service scientists have found a way to keep the nuts free of codling moths.

Japan does not have the codling moth and has been quarantining walnuts and certain other products that might bring the pest into the country from the United States and other foreign countries. The codling moth damages apples, pears, and some other fruits and is also found in walnuts.

To kill the codling moth if present in walnuts, scientists use safe yet higher-than-normal doses of the regular walnut fumigant methyl bromide in a vacuum chamber. That will kill any codling moths that might be hiding in the harvested nuts, says Patrick V. Vail, an entomologist and director of the agency's Horticultural Crops Research Laboratory, Fresno, CA.

"We now have a way to guarantee that unshelled walnuts are free of live codling moths," says Milton T. Ouye, the ARS coordinator for commodity treatments.

Japan recently lifted an import ban against unshelled walnuts from U.S. orchards because of the effectiveness of vacuum fumigation tests at Fresno.

That will give walnut exporters a new market and may give them incentive to invest in costly vacuum equipment, says Ouye, who is based in Beltsville, MD.

To control insects, methyl bromide is routinely applied to shelled and unshelled walnuts with less expensive equipment at normal (atmospheric) pressure. The fumigant is usually applied in lower doses than in the vacuum method.

Fresno scientists found that the higher doses are needed to kill the occasional codling moth larva that is living inside a walnut at harvest time. At this "overwintering" stage of its life, it is twice as resistant to fumigants as at any other time.

The new dosage overpowers the moth's increased tolerance, and the vacuum helps the fumigant penetrate the shell.

Unshelled walnuts have a longer shelf life than shelled nutmeats and would probably be promoted as a consumer product in Japan. Shelled nutmeats, in contrast, are sold primarily to industrial customers, such as bakeries.

After Australia and West Germany, Japan is currently the third largest importer of U.S. shelled walnuts. The 1985 U.S. walnut crop, produced almost entirely in California, was valued at $161 million.—By **Marcia Wood,** ARS.

Patrick V. Vail is at the USDA-ARS Horticultural Crops Research Laboratory, 2021 South Peach Ave., Fresno, CA 93727. ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

New Bacterium Fights Pythium Disease of Cucumbers, Peas

A new type of beneficial soil bacterium that can reduce the occurrence of *Pythium* diseases in cucumbers and peas has been patented by Agricultural Research Service scientists. Pythium causes root rot and the condition known as "damping off" in which seeds and seedlings are killed.

The bacterium, designated as SDL-POP-S-1, is *Pseudomonas cepacia*, a species in the genus *Pseudomonas* which includes other proven biocontrol agents.

A new medium exclusively selective for the bacterium *P. cepacia* has also been developed. The medium, PCAT, was used to isolate the bacterium from soil.

For technical information, contact Robert D. Lumsden, USDA-ARS Soilborne Diseases Laboratory, Building 011A, Room 262, Beltsville Agricultural Research Center, Beltsville, MD 20705. *Patent No. 4,588,584, "Medium for the Isolation of* Pseudomonas Cepacia *Biotype From Soil and the Isolated Biotype."* ■

New Sensor Ensures Top Quality Cotton Fiber

The amount and quality of cotton fiber that gins can strip off cotton seeds depend heavily on moisture content. Gin operators have not been able to obtain continuous, accurate cotton moisture measurements while the cotton is going through the machinery.

Now engineers have developed a contact sensor that measures both moisture and fiber packing density instantaneously as cotton is processed. Several of these new sensors could conceivably be attached to a computer to completely automate moisture control in gins.

The sensors fit on the outside of equipment that stores or transports cotton within the ginning plant, so they can be installed without extensive modification.

For technical information, contact Ed Hughs, USDA-ARS Southwestern Cotton Ginning Research Laboratory, P.O. Box 578, Mesilla Park, NM 88047. *Patent Application Serial No. 818,564, "Fluidic Permeability Measurement Bridge."* ■

How To Obtain a License for USDA Patents

A listing of all U.S. Department of Agriculture patents is available on request. If you are interested in applying for a license on a patent or receiving the catalog, write to the Coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705.

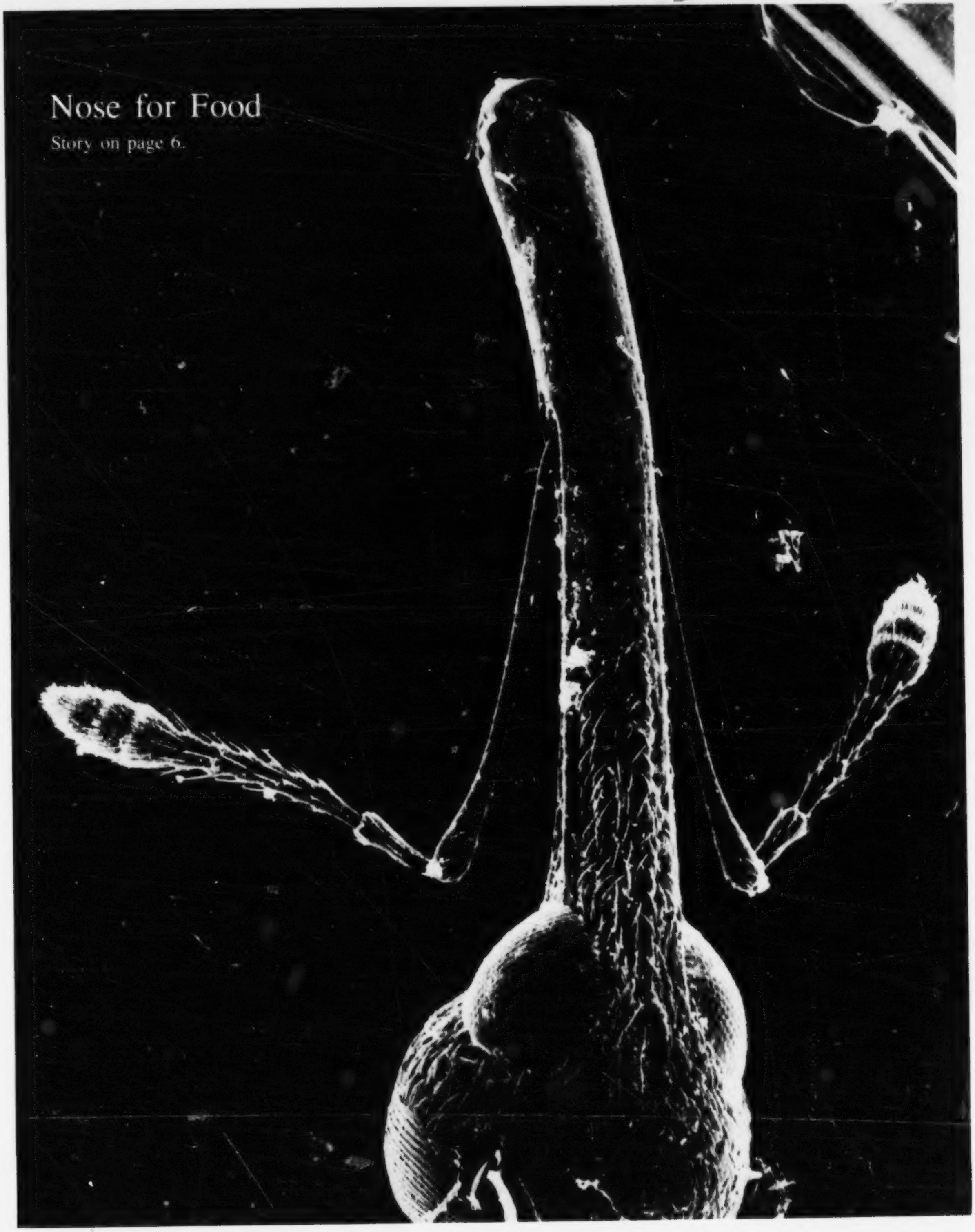
Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

34/9

U.S. Department of Agriculture   Agricultural Research Service   Vol. 34, No. 9, October 1986

NEWARK PUBLIC LIBRARY
OCT 20 198
U. S. GOVT. PUBS.
DEPOSITORY 376

Agricultural Research



Nose for Food

Story on page 6.

A 77.12:

FORUM

Breaking the Time Barrier

Think what it would mean to solve a vexing agricultural problem in years rather than decades. To know what to do about a crop disease now rather than later could save millions of bushels of grain or pounds of produce for a farmer. It could mean the difference between a profitable operation and a foreclosure.

Few could argue that sooner isn't better than later when it's a pest that is destroying a crop or erosion robbing the land of its productive ability.

But can science be hurried? No, not in the strictest sense, because the solution to a problem only follows a process where data is painstakingly collected, compiled, analyzed, reviewed, and replicated. Some of the steps in this process, however, can be shortened dramatically by imaginative researchers.

Consider, for example, the Sunhigh—a tasty, freestone peach grown in the eastern United States. Bacterial leaf spot disease has taken the Sunhigh variety off the market.

The conventional approach to this problem would be to plant peach seeds and expose the young seedlings to leaf spot bacterium until one was found to be resistant—a procedure that could span years and occupy acres of greenhouse or orchard space.

An innovative researcher at the Beltsville (Maryland) Agricultural Research Center found a way to speed up the search by testing millions of peach cells in a laboratory growth medium laced with toxin from the bacterium.

The successful experiment was a first for producing a disease-resistant tree from a disease-susceptible variety and took less than a year in laboratory space not much larger than a refrigerator shelf.

Another scientist at Beltsville slashed the time needed to develop rice with a more nutritious protein. He did it by using a chemical that killed all rice pollen cells that had low levels of lysine, an essential amino acid. The chemical selection eliminated a random search through hundreds of thousands of rice plants. After developing the technique, his actual search for a better rice took only 2 years, compared with the usual 5 or 6 needed for traditional selection techniques.

Another way to hurry research is to grow only the part of a plant that is under study. In experiments partially funded by ARS, a Texas Tech University researcher found a way to grow cotton fibers in a test tube without any other part of the plant. This isolation of one plant part allows scientists to avoid a lot of distracting variables (insects and the weather for example), and it gives them a steady, year-round supply of plant material for research.

Not that biotechnology is the only way to speed up plant work. An ARS scientist in California found a way to hasten traditional breeding techniques. An ingenious idea came to the scientist when he noticed that some lettuce plants were bypassing the leaf production stage and producing flowers in about 50 days, instead of the usual 120 days. Since the early flowering is caused by a partially dominant gene, why not use only plants with that gene when breeding for a desired trait? The speedy gene would shorten each plant's generation by about 70 days and could be bred out once the trait was transferred. Using this technique, the scientist expects to transfer lettuce mosaic disease resistance into Prizehead lettuce, a susceptible commercial variety, in about 550 days rather than the usual 875.

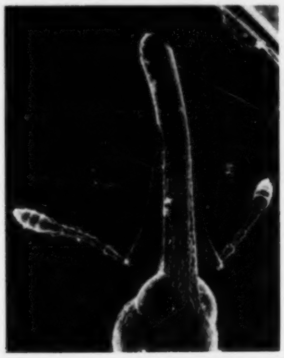
Time-and-space-saving techniques aren't limited to the plant world. Imagine sitting in a lab office and at the punch of a computer button being able to weigh a cow or take her temperature while she drinks water 5 miles away! That's what ARS scientists are doing in Montana and New Mexico.

The computerized weighing system uses electronic devices to open a gate that allows only one cow to enter at a time for a quiet drink at the trough. The cow doesn't even realize she is standing on a scale.

The computer that receives the weights by radio is one of many used by ARS scientists. Computers analyze in seconds what would take a person hours to months.

Computers are now used to simulate natural processes over months, years, decades, and centuries in a matter of minutes or hours. For example, an ARS team working with an economist from USDA's Economic Research Service put together a computer model, EPIC (Erosion-Productivity Impact Calculator), that can recreate the subtle process by which erosion slowly robs soil of its ability to grow a crop over a period as long as several hundred years. The simulations can replace field research that often took several years, even decades, to complete.

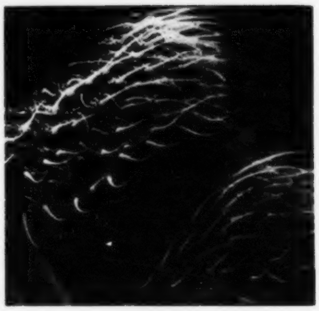
The list of uses for computers and other new time-saving technologies is long and covers the full range of research from insect neurochemistry to plant and animal genetics to human nutrition needs. The limitations of time, funding, and working space often give way when ARS ingenuity is applied to these technologies.—**Don Comis**, ARS



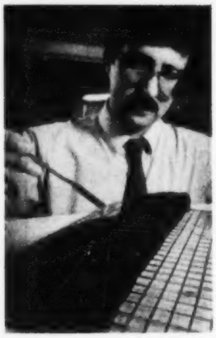
Agricultural Research

Cover: Antennae of the cotton boll weevil are mounted on the sides of its snout. As with other insects, the boll weevil relies on antennae and other body parts for its sense of smell. Story begins on page 6. (Magnification 60 times. Scanning electronmicrograph by Joseph Dickens. PN-7209)

p.8



p.7



p.5

6 Electrical Probes Reveal How Insects Smell

The goal is to prevent agricultural pests from finding mates or pinpointing egglaying sites in ripe fruit.

8 New Peach Unmarked by Leaf Spot Disease

Searching for disease resistance at the cellular level pays off against one-in-a-million odds.

10 Flight Tests Show How Wasps Locate Prey

Zigzag flight patterns are really not so random. Scientists find wasps follow scents in the air.

11 Choosy Soybeans Fix More Nitrogen

Strangely enough, some of the best strains of nitrogen-fixing soil bacteria are excluded by many soybean varieties.

DEPARTMENTS

4 AgNotes:

Exploded Mushrooms: Gourmet Food or Snack
Vapor-Locked Plants Resist Freezing
Asthma Symptoms Eased by Vitamin B-6
Brownies With Fewer Calories

12 Technology:

Farm Surpluses: Sources for Plastics
X-Ray System Finds Contraband Fruit, Plants
Test for Spoilage in Liquid Eggs

16 Patents:

Plant Fiber Additive for Food
Turning Surplus Crops Into Plastics
Detection of Agricultural Contraband
Computerized Windmills
Detecting Immunoglobulins in Swine

Vol. 34, No. 9
October 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Daniels
Art Director: Deborah Taylor

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to:
The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705.
Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

AGNOTES

Exploded Mushrooms: Gourmet Food or Snack

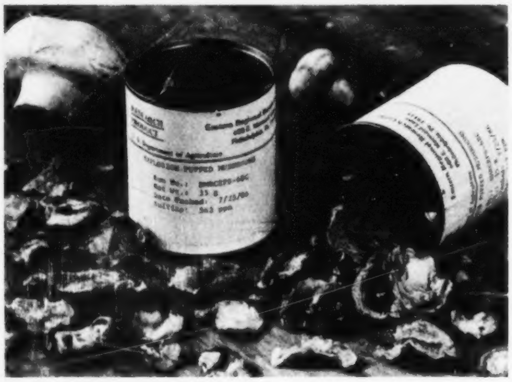
Mushrooms can now be "puff-dried," stored indefinitely, and then cooked in boiling water, while retaining their flavor and texture. Uncooked, the mushrooms can be eaten as a new snack that is tasty, nutritious, and low calorie, says a scientist for USDA's Agricultural Research Service.

"Puff-dried mushrooms are of higher quality than those conventionally dried," says Michael Kozempel, a chemical engineer at the agency's Eastern Research Center in Philadelphia. "They retain more nutrients, especially B vitamins, and are easy to rehydrate."

"I foresee one very popular use as a dry product," he says, describing the low-calorie, puff-dried mushroom bits as "crunchy, something like croutons people sprinkle on salads."

Unlike conventionally dried mushrooms that are flat, hard flakes, explosion-puffed mushrooms have a porous texture that allows them to take up water rapidly. Popping them into boiling water for 5 minutes makes them suitable as a food condiment or an ingredient in soups.

In the puff-drying system, high air pressure is exerted on batches of mushrooms. When the pressure is suddenly released, the "moisture inside them literally explodes," says John Sullivan, a chemical engineer who with mechanical engineer Wolfgang Heiland developed explosion puffing of fruits and vegetables at the Philadelphia center.



Mushrooms before and after explosion-puffing. End product is a tasty, nutritious snack whether eaten 'as is' or rehydrated in boiling water. (0986X1036-34)

The process can save 40 percent of the energy required in conventional food-drying systems.—By **Stephen Berberich,** ARS.

Michael Kozempel and Wolfgang Heiland are at the USDA-ARS Eastern Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. John Sullivan is now retired. ■

Vapor-Locked Plants Resist Freezing

Even at subzero temperatures, parts of some plants simply refuse to freeze. Uniquely arranged microscopic pores and vessels inside the plants may be what protects them, according to a USDA Agricultural Research Service scientist.

"Based on preliminary studies, I believe a few plants, like the plum tree, may resist freezing because the pores and vessels that connect the stems and flowers have the ability to stay dry," says John W. Cary, who recently retired from the agency. "Although it is still a theory, it's one of the more intriguing things I've found in my 30 years of research.

"No one knows what the best arrangement of these tiny pores and vessels is," says Cary. "But we do know certain plant flowers—like plums, wild violets, and wild currants—naturally tolerate freezing.

"If we could transfer this type of protection to frost-prone crops," he says, "we could greatly expand the area now used to grow produce of all kinds. Breeding plants to change the arrangement and distribution of tissue pore size may be a key to reducing a plant's vulnerability to frost.

"But a lot of research still has to be done," he says. "It could take 15 or 20 years to breed frost-resistance into plants."

Cary's findings run counter to those of other researchers who have speculated that a special membrane somewhere in the plum bud may prevent ice from forming in—and destroying—the plum ovary.

"My theory," says Cary, who until June was a soil scientist at the Snake River Conservation Research Center in Kimberly, ID, "is based on the special arrangement of pores and vessels in the plum tree. This arrangement allows water in the plum flower to flow away from the base of the ovary because it is attracted to ice crystals that have already formed nearby—in the stem. These crystals draw water, much like a blotter.

"This leaves a dry, dehydrated area in the base of the ovary," says Cary. "The dry pores and vessels surrounding the ovary are filled with vapor instead of liquid. This stops more water from entering the ovary area—even if temperatures drop 8 or 10 degrees below freezing.

"It's like a vapor lock that forms in your car's fuel line and keeps gas from entering the engine," says Cary. "In the plum, the result of this vapor lock is that the ovary, now shielded from freezing, remains fertile and able to form fruit."
—By **Howard Sherman,** ARS.

John W. Cary, recently retired, was at the USDA-ARS Snake River Conservation Research Center, Kimberly, ID 83341. ■

Asthma Symptoms Eased by Vitamin B-6

Controlled dosages of vitamin B-6 alleviate shortness of breath and other symptoms of bronchial asthma, according to preliminary findings of USDA Agricultural Research Service and Columbia University scientists.

In a 2-year study, a 100-milligram oral dose of the vitamin was given daily to 15 asthma patients. All experienced fewer and less severe attacks, says Robert D. Reynolds, an ARS chemist.

"For the first time, we have confirmed that blood of adult asthma sufferers is low in vitamin B-6," Reynolds says. "Our preliminary results show a relationship between very low levels of the vitamin and asthma." Other researchers had previously theorized that vitamin B-6 deficiency might be a factor in asthma attacks.

Reynolds cautions that vitamin B-6 is not a cure for asthma. The normal dietary intake of vitamin B-6 is 1.5 to 2.0 milligrams a day, and indiscriminate use of higher doses of the vitamin may lead to serious nerve damage. The daily 100-milligram doses used in the study, he stresses, were given only under a physician's care.

About 9 million people in the United States suffer from some form of asthma, an ailment that costs them over $1 billion a year for prescriptions and over-the-counter drugs.

Reynolds and co-researcher Clayton L. Natta of Columbia University in New York uncovered the asthma/vitamin B-6 link during a study of sickle cell anemia patients. (See *Agricultural Research*, Vol. 33, No. 1, Jan. 1985, p. 4)

In that study, much to their surprise, they found some of the group not suffering from sickle cell anemia had lower vitamin B-6 levels than the sickle cell anemia patients.

A search of their medical backgrounds revealed that all of them suffered from bronchial asthma, a fact unknown to the researchers before the study began.

Natta carried out the vitamin B-6 and asthma tests at Columbia University-affiliated hospitals in New York. He directed the vitamin dosages and blood sampling, and Reynolds performed the laboratory analyses.

Further research on the effects of vitamin B-6 on asthma is being carried out in cooperation with Ronald Simon of Scripps Clinic, La Jolla, CA. The study involves 45 adults and will continue for 2 years. "These studies should tell us if our preliminary results are valid," Reynolds says.—By **Vince Mazzola**, ARS.

Robert D. Reynolds is at the USDA-ARS Vitamin and Mineral Nutrition Laboratory, Beltsville Human Nutrition Research Center, BARC-East, Beltsville, MD 20705. ■

Brownies With Fewer Calories

Weight-conscious people may someday be able to enjoy less fattening cakes, brownies, and donuts, thanks to a no-calorie, high-fiber supplement developed by USDA's Agricultural Research Service.

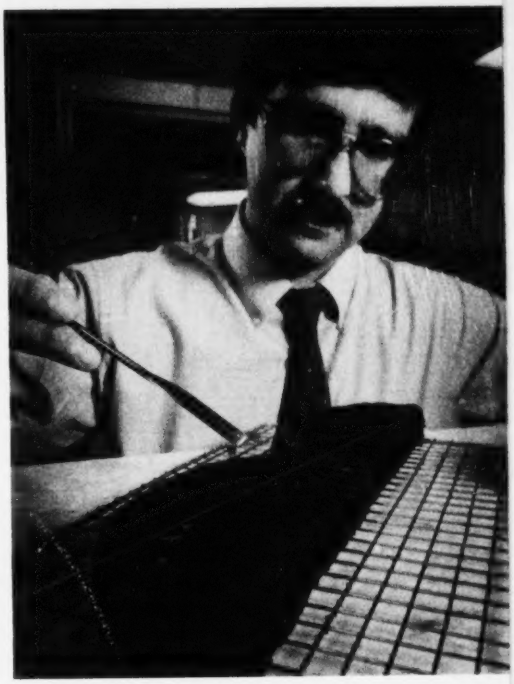
The substance is a naturally occurring combination of cellulose and hemicellulose, two building blocks of plant cell walls. It can be prepared from a variety of sources—such as bran or straw from wheat, oats, and corn—by treating these materials with a dilute solution of hydrogen peroxide under special conditions.

The resulting fluffy fibrous material combines with other food ingredients, such as flour, much more readily than does untreated bran or other fiber supplements, according to chemist J. Michael Gould, who developed the process.

Research by Gould and biological technician Lee B. Dexter indicates that the fiber supplement could replace some of the flour used in baked goods, prepared mixes, and other foods without changing taste and texture. It could also be used as a thickening agent in instant drink mixes, milk shakes, and jelled foods.

The fiber is comparable to that found in wheat bran, but its baking properties are much better: While adding bran can cause bread loaves to rise less, peroxide-treated fiber is readily absorbed into batters and doughs without reducing baked volume.

In laboratory experiments, Gould and chemical engineer Brian K. Jasberg found that they could make a white bread that looks, feels, and tastes like any other white bread but contains as much fiber as whole wheat bread. Ordinarily, white bread has about a third as much dietary fiber as whole wheat bread.



Chemist J. Michael Gould, in laboratory kitchen, points to cake in which 20 percent of the flour was replaced with treated wheat straw. Next to it, a cake made with ordinary flour. The additive could provide more fiber and fewer calories in baked goods. (0986X1021-21A)

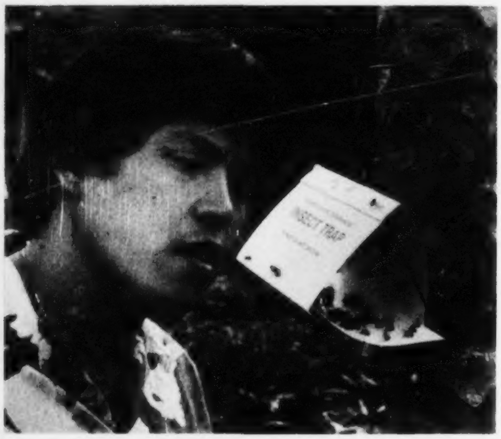
For example, they replaced 10 percent of the flour in a 1-pound loaf of bread with treated fiber from corn plants. The high-fiber bread contained about 14 percent fewer calories than white bread.

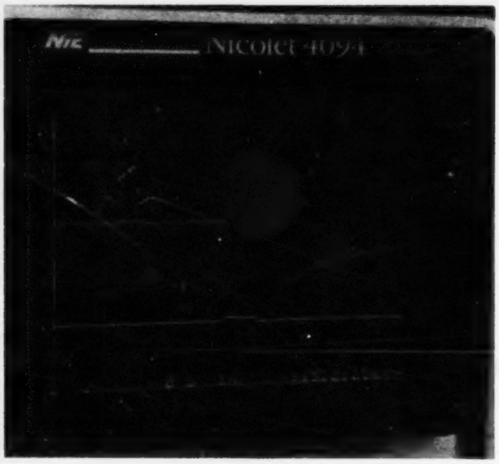
Gould and Jasberg have also incorporated treated fiber into normally calorie-rich, low-fiber foods such as cakes. A slice of their chocolate cake contains about as much fiber as a plate of lettuce and has 25 percent fewer calories than ordinary chocolate cake.

USDA is currently seeking a patent for the process.—By **Ben Hardin** and **Caree Lawrence,** ARS.

J. Michael Gould, Lee B. Dexter, and Brian K. Jasberg are located at the USDA-ARS Northern Research Center, 1815 North University Street, Peoria, IL 61604. ■

Electrical Probes Reveal How Insects Smell





Top: ARS entomologist Eric Jang inspects fruit fly trap on papaya tree. He is currently testing new synthetic odors in hopes of learning more about how insects perceive sensory stimuli such as odors. (0486X518-16A)

Above. Oscilloscope reading of electroantennograms. Sharp drop in top tracing shows that insect has responded to odor. Bottom tracing indicates length of exposure to stimulus. (0486X520-13)

Tiny probes inserted into the antennae of insects may reveal how these pests find and home in on the scents of ripening fruit or other crops they attack.

Scientists at USDA's Agricultural Research Service are using these delicate electrical probes to study the Mediterranean fruit fly (medfly), the boll weevil, and more than a dozen other voracious agricultural pests.

Such crop-damaging pests, like other insects, don't have noses that detect odors, so they rely primarily on their antennae for their sense of smell, says Eric B. Jang, an ARS entomologist in Hilo, HI.

Once Jang inserts the probes, they record electroantennograms—readings on the TV-like screen of an oscilloscope—that indicate whether the medfly can detect a specific odor. It may be the natural scent of ripening fruit or of a prospective mate or some other smell in the medfly's world.

"We puff an experimental odor near the insect," he says. "The probes will pick up even the slightest electrical response from the insect's supersensitive antennae."

Agency scientists cooperating in the medfly research, entomologists Joseph C. Dickens in Mississippi and Douglas M. Light in California, take electrical recordings of a different type—from individual nerve cells in the antenna or from single nerve cells in the brain.

But the goal of the three scientists is the same: To devise powerful new ways to disrupt the medfly's seemingly unerring ability to use chemical communication for finding potential mates and to respond to fruit odors in finding egglaying sites in susceptible crops.

According to Jang, besides their use for understanding how fruit flies perceive odors, electroantennograms offer other promising possibilities for future strategies to control the medfly.

Electrical responses might someday be used to identify harmless compounds that could be applied to crops to confuse and deceive the insects and thus protect fruits they would otherwise attack.

"The female fruit fly will attack certain fruits only when conditions are right for laying eggs inside the fruit," Jang says. "This means that the fruits must be at just the right stage of ripeness. What if we could confuse flies—and protect the crops—by spraying the ripening fruits with a harmless scent of unripened fruit?"

"What if we could confuse medflies—and protect the crops—by spraying ripening fruit with a harmless scent of unripened fruit?"

—**Eric B. Jang,** ARS entomologist

Electroantennograms were developed in the mid-1950's by a German scientist. They were followed by increasingly sophisticated variations—such as single-cell recordings.

At the agency's Boll Weevil Research Laboratory, Mississippi State, MS, Dickens is one of only a few scientists in the world who use single-cell recordings from the antenna.

Unlike Jang's work, which provides information about the antenna as a whole, Dickens records an individual olfactory nerve cell's response to specific scents. These cells are housed within thousands of hairs that make up the antenna.

Dickens relies on probes that are even finer than the ones Jang uses. He carefully positions them into the base of individual hairs, as close as possible to the nerve cells.

"Each olfactory nerve cell may have a specialized role in detecting specific scents," he says. "Cells in any given hair are well insulated from cells in other hairs and so react independently."

When an olfactory nerve cell

responds to a specific scent, it sends a signal, along a fiber called an axon, to the brain. For example, some signals may indicate to the female medfly that conditions on a fruit are right for her to begin laying her eggs within the fruit.

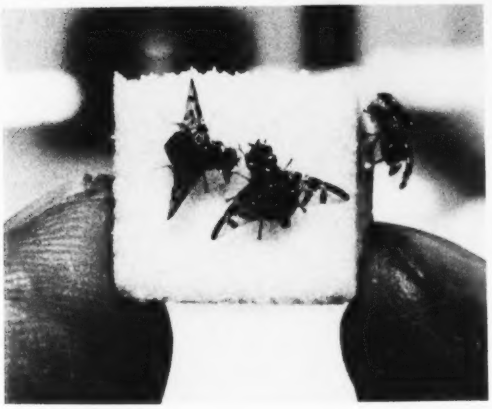
It is the insect's brain that integrates the incoming signals, says Light, at the ARS Western Research Center in Albany, CA. He inserts probes in specific regions of the insect's brain.

"We use these recordings to learn how the individual brain nerve cells receive and process the incoming information about scents from the olfactory nerve cells of the antennae," he says.

Light will be studying extremely small nerve cells within the medfly's very tiny brain. "Because the medfly's brain is about 20 times smaller than that of a large moth, medfly recordings could be very difficult to make."

"Our intent is to take what we learn and use it against insects that cost farmers money," Jang says.—By **Marcia Wood,** ARS.

Eric B. Jang is at the USDA-ARS Tropical Fruit and Vegetable Research Laboratory, Hilo, HI 96720. Joseph C. Dickens is at the USDA-ARS Boll Weevil Research Laboratory, Mississippi State, MS 39762. Douglas M. Light is at the USDA-ARS Western Research Center, Albany, CA 94710. ■



Above: Long hairs on antennae of male southwestern cornborer sense sex attractants, or pheromones, sent out by female cornborer. Magnified about 700 times. SEM by Joseph Dickens. (PN-7210)

Left: Mediterranean fruit flies (medflies) are among the leading pests of tree fruit in the United States and abroad. (0486X518-7A)

Top right: Each medfly antenna is a forest of hairs, called sensilla, which house olfactory nerve cells. Single-cell recordings from these cells reveal how they respond to specific scents. Magnified 2,700 times. SEM by Joseph Dickens. (PN-7211)

New Peach Unmarked by Leaf Spot Disease

Peach growers, and peach eaters, should be pleased that Freddi A. Hammerschlag has beaten the odds.

Out of 3 million peach cells taken from immature seeds of the Sunhigh variety, she found two cells that fight off bacterial leaf spot. Leaf spot, caused by the bacterium *Xanthomonas campestris pv. pruni,* is one of the fruit's worst diseases. From these two cells, she grew two plants that were significantly more resistant to leaf spot than any known resistant variety she tested.

The odds against finding mutant plants were extremely slim, but she improved her chances by using tissue culture techniques to screen large numbers of cells. Tissue culture is a way of keeping plant cells, tissues, and organs alive in laboratory dishes with a mix of nutrients and hormones.

Hammerschlag took less than a year to find the mutants by repeatedly exposing the peach cells to leaf spot toxin and then growing the survivors in nutrient-filled jars.

"I started with 400 clumps of peach embryo tissue, each containing thousands of cells," says Hammerschlag. "The two surviving cells came from a total cell population of around 3 million. It is impossible to do selection work with that many plants in a field or greenhouse."

Hammerschlag mixed the toxin from leaf spot bacterium into a growth medium for the 400 clumps. After several weeks of exposure, most of them turned brown, but tiny swellings of new growth appeared from within two of the clumps. Several more weeks of encouraging this new growth with hormones provided the scientist with two highly resistant shoots, which she then cloned into many more plants.

"It's the first time we've produced in the laboratory a disease-resistant woody plant from cells that came from a disease-susceptible variety," she says.

Over the next 2 years, young trees will be transplanted to orchards in North Carolina. Field tests there will show if the test-tube trees are indeed resistant outside of the laboratory.

Leaf spot is a major disease of East Coast peach orchards, and there is no effective pesticide. In damaging Sunhigh trees in commercial orchards, the disease keeps one of the best peaches off grocers' shelves, in Hammerschlag's opinion, which is backed by a USDA study of fruit quality.

> ***"It's the first time we've produced in the laboratory a disease-resistant woody plant from cells that came from a disease-susceptible variety."***
>
> —**Freddi A. Hammerschlag,** ARS plant physiologist

If she has indeed beaten the odds against finding a resistant mutant, her technique may benefit growers of crops other than peaches. Disease pathogens of many other woody plants use toxins to break into plant tissue and steal nutrients. In the future, researchers may be able to rapidly select for resistance to these pathogens with a similar procedure.

For decades, Hammerschlag says, fruit tree breeders have focused on improving the fruit itself, how it tastes, appears, and keeps. "Other important factors, such as disease resistance and cold tolerance have been neglected."

Hammerschlag cautions that if the North Carolina field tests confirm the resistance, peaches from the new trees will still have to be studied for market qualities.—By **Stephen Berberich,** ARS.

Freddi A. Hammerschlag is at the USDA-ARS Tissue Culture and Molecular Biology Laboratory, BARC-West, Beltsville, MD 20705. ■

Above: Plant physiologist Freddi Hammerschlag displays fruit of her labor—vial containing bacterial spot-resistant peach shoots grown from cells. (0985X998-29)

Left: Peach shoots in growth medium. The first whole trees will be field tested in North Carolina to determine degree of resistance to leaf spot bacterium. (0586X656-6A)

Far left: Biological laboratory technician Brenda Pressnall removes peach shoot tips from trees grown through tissue culture to be used for further cloning. (0986X1017-31A)

Tissue Culture for Fast Growth

Plant tissue culture is a laboratory technique by which whole plants or parts of plants can be quickly cloned from bits of tissue or individual cells. They are nurtured in a liquid or semisolid medium containing minerals, vitamins, sugar, synthetic hormones, and sometimes antibiotics.

Tissue culture's big attraction for commercial propagators is the speed at which the plants multiply—a geometric progression as each plantlet is cut up into pieces that in turn produce more plantlets. Pecans, hazelnuts, almonds, pears, apples, sweet and sour cherries, nuts, peaches—it's hard to name a horticultural crop that hasn't been produced by a commercial tissue culture lab, although total production remains far less than for conventional propagation methods.

Tissue culture is essential in research using genetic engineering and other biotechnologies, because it is the way altered cells can be increased in number in a short time.

In some cases, tissue culturing provides both the quickest and most reliable way to propagate a crop.

For example, it was a natural choice for Sri Lanka when the search began for a fast way to replace its aging tea orchards—some of them a century old. Conventional propagation techniques would take too long. They couldn't afford to wait that long for new orchards to produce Ceylon tea, a crop important to the island's economy.

In 1985, Sri Lanka requested Freddi A. Hammerschlag, a plant physiologist with the Agricultural Research Service, to assist them in renewing their tea orchards. Since her visit, Sri Lanka has sent four of their scientists to work on micropropagation techniques with Hammerschlag at the ARS Tissue Culture and Molecular Biology Laboratory in Beltsville, MD.

In addition to tea, Sri Lanka hopes to improve propagation of plants for coconut, rubber, cinnamon, and spices.—**D.C.** ■

Flight Tests Show How Wasps Locate Prey

Insects buzz around and zigzag through the air in a way that's far more systematic and predictable than one might think. For over 2 years, W. Joe Lewis and Michael A. Keller of USDA's Agricultural Research Service have been studying the flight patterns of females in a certain wasp species with the meticulous concentration of pro football coaches analyzing the moves of an elusive wide receiver.

"I guess that might be an apt comparison," says Lewis. "We use stop watches and video equipment, and we replay the tapes over and over again and chart each move the wasp makes. But there is one big difference.

"We aren't trying to stop the wasp. As a matter of fact, it's a good wasp to have around because instead of stinging people, it attacks caterpillars that eat a lot of crops."

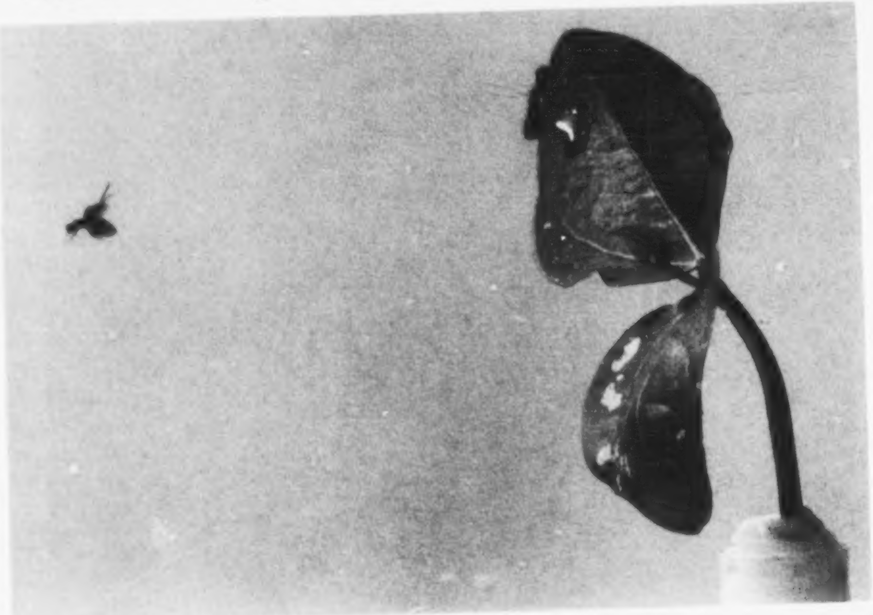
> ***"It's a good wasp to have around because instead of stinging people, it attacks caterpillars that eat a lot of crops."***
>
> —**W. Joe Lewis**, ARS entomologist

Lewis and Keller want to know how beneficial insects like the wasp actually go about finding their prey. They say that artificially reared wasps brought into target areas often get discouraged while flying around because they can't detect enough signs of the insects they are hunting. Then they decide to leave the area and look elsewhere.

Understanding this behavior could eventually help farmers use these natural allies more effectively against the caterpillar and other destructive insect pests.

Flight chamber studies by Lewis and Keller at the agency's Insect Biology and Population Management Laboratory in Tifton, GA, show that the wasp flies specific and discernible routes. Such flight patterns enable it to detect odors created by caterpillars feeding on plants and to zero in on these odors.

"We have to know which odors are important to the wasp," says Lewis, "and flight patterns are telling us a lot. We know the wasp distinguishes odors during flight, and we can see her adjust her flight path according to air currents and the odors they carry."



Wasp flying toward caterpillar feeding on leaf of bean plant. Odors emitted by caterpillar during feeding serve as attractant to wasp. (0786X818-30A)

To know precisely which odors attract the wasp, Lewis and Keller work closely with ARS chemist James Tumlinson in Gainesville, FL. According to Tumlinson, the odor created by a caterpillar chewing into a leaf is chemically different from the odor of either an unbitten leaf or the odor of a caterpillar by itself.

Keller says, "Once we know the chemical makeup of each odor the wasp is pursuing—and the makeup of each odor she doesn't like—we should be able to significantly improve biological control programs in which the wasp is deployed."

Joining Lewis and Keller in their studies of the wasp are scientists from France and Holland, two of the European countries also studying ways to use this type of wasp.

The big obstacle to effective wasp deployment in both Europe and America is convincing wasps artificially reared in massive numbers to behave the way wasps reared in the wild do. "And it really is a matter of teaching them," says Keller.

ARS entomologist Joe Lewis (left) prepares to attract wasp by placing caterpillar larvae on bean plant while research associate Mike Keller gets ready to release wasp into flight cage. (0786X819-14)

"We can keep artificially reared wasps in the field where they're most needed," he says, "by exposing the wasps to the odors of caterpillars before releasing them. Then they'll know what to look for. And if the odors in the field aren't strong enough, we can add to them as well."—By **Steve Miller**, ARS.

W. Joe Lewis and Michael A. Keller are in the USDA-ARS Insect Biology and Population Management Laboratory, P.O. Box 748, Tifton, GA 31793-0748. ■

Choosy Soybeans Fix More Nitrogen

Soybean plants that prefer to root down with a better class of nitrogen-fixing soil bacteria are what geneticist Perry B. Cregan and microbiologist Harold H. Keyser want, and they are beginning to find them. The plants could help U.S. soybean farmers boost profits.

These USDA Agricultural Research Service scientists at the Nitrogen Fixation and Soybean Genetics Laboratory at Beltsville, MD, found 13 superior plants among 1,300 genetically different types of soybeans. During the 2-year search, they picked through uncounted soybean root systems to find signs of a more fruitful partnership between plant and bacteria.

Just below the surface of farm fields, dozens of strains of the soil bacterium *Bradyrhizobium japonicum* battle for the right to get inside soybean roots. And, say Cregan and Keyser, it's the soybean plant that appears to be in charge of which bacteria infect them.

Just below the surface of farm fields, dozens of strains of the soil bacterium* Bradyrhizobium japonicum *battle for the right to get inside soybean roots.

The root tissue somehow selects only specific strains of the bacteria which are then fed and housed in nodules formed on the roots in response to the infection. The bacteria return the favor by changing nitrogen from pockets of air in the soil into fertilizer that helps the plant grow.

Bradyrhizobium bacteria infect the tips of roots, then follow an infection thread created by invaginated, or infolded, plant cells. The nuclear DNA of the soybean seems to direct the penetration of the root tissue. By a yet unknown process, strains not favored by a particular plant fail to cause formation of nodules. Compounding the problem: The bacteria strains most favored by U.S. soybean varieties are weak in fixing nitrogen.

Early in the century, farmers would carry soil from one soybean field to the next and sprinkle it onto seeds before planting. This would ensure that the bacteria in the soil would fix nitrogen for their crop.

Since the 1940's, commercial peat and powder products containing the bacteria have been sold to farmers, who coat seeds with the products before planting.

Although research may be poised for genetic engineering of super strains of nitrogen-fixing bacteria for coating seeds, such strains will be useless if soybean varieties continue to form nodules only with inefficient strains already living in fields.

The strategy of Cregan and Keyser, therefore, is to make no further changes in the bacteria while they work on soybean plants with an exclusive preference for improved strains of nitrogen-fixing bacteria.

Significantly, the plants found so far tend to exclude strain USDA 123, a highly competitive but ineffective nitrogen-fixing bacterium that is solidly entrenched in midwestern soybean fields. Six midwestern states produce more than 60 percent of the U.S. soybean crop each year.

Cregan thinks he and Keyser have uncovered two genes in the choosy plants that each command exclusion of some subgroups of USDA 123 bacteria. Their goal is to identify genes that exclude all the subgroups.

So far, 13 types of soybean plants of 1,300 screened exclude some USDA 123 bacteria. However, there are 10,000 to 12,000 genetically different types of soybean plants known, so the scientists have their work cut out for them.

The world's largest repositories for soybean plant material are ARS facilities at Stoneville, MS, and Urbana, IL. Scientists at both locations are supplying Cregan and Keyser with seeds for their experiments.

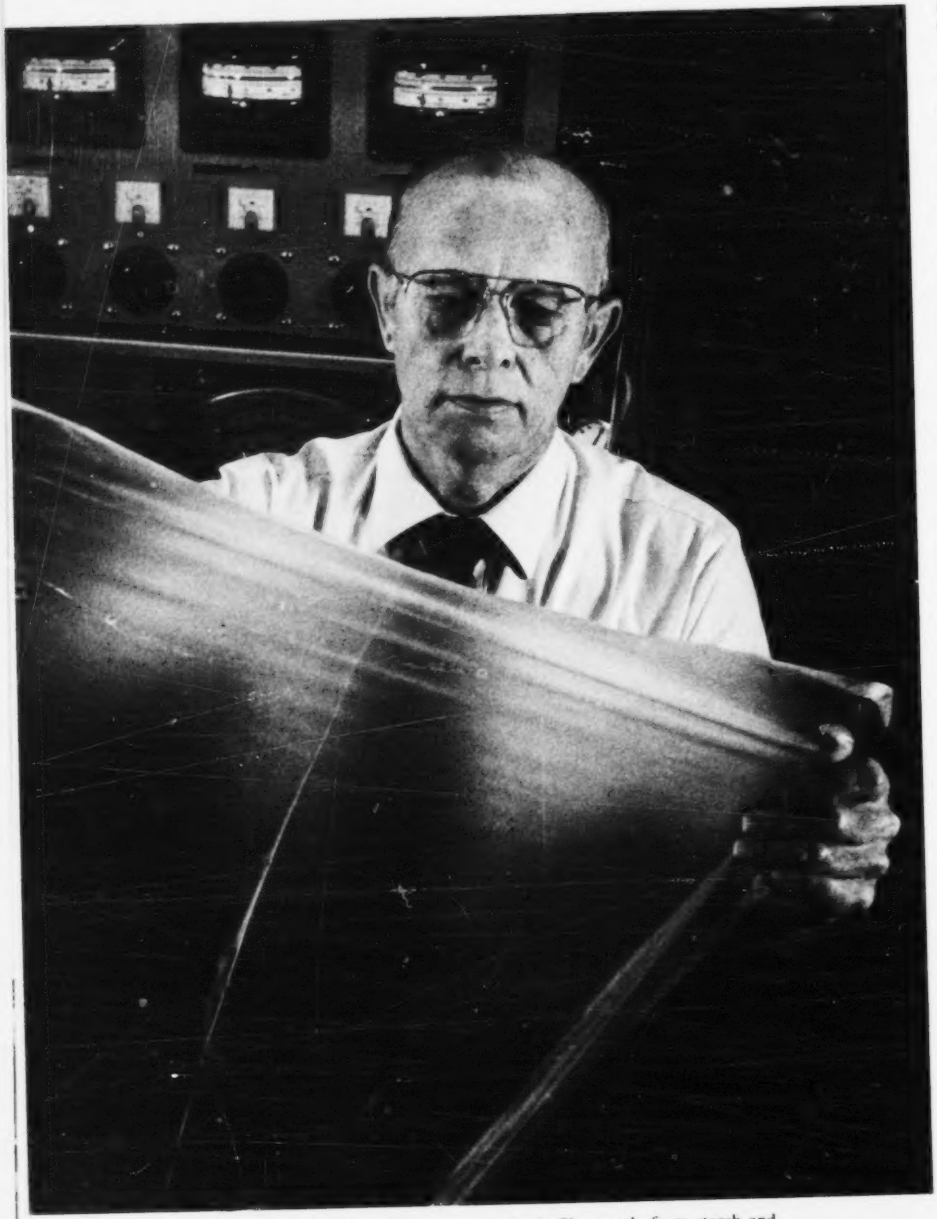
The laboratory's newest member, molecular geneticist Michael J. Sadowsky, will spearhead the first effort to unravel the genetic control of nodulation by *Bradyrhizobium* USDA 123.

Over the next 2 years, Cregan, Keyser, and Sadowsky will further study choosy genes in soybeans with the help of a grant from USDA's Cooperative Grants Program.—By **Stephen Berberich,** ARS.

Perry B. Cregan, Harold H. Keyser, and Michael J. Sadowsky are at the USDA-ARS Nitrogen Fixation and Soybean Genetics Laboratory, HH-19, Range 1, BARC-West, Beltsville, MD 20705. ■

TECHNOLOGY

Farm Surpluses: Sources for Plastics



ARS chemist Felix Otey displays large sheets of plastic film, made from starch and petroleum-based polymers, which were processed on a commercial extrusion blowing machine. (0986X1019-6)

Starch from corn may soon replace petrochemicals in plastic films. And glycerol—a byproduct from processing of animal fats, soybeans, and other vegetable oil crops—may one day compete with petrochemicals in acrylic plastic manufacturing.

These are two examples of how research may help convert the nation's surplus farm commodities into needed industrial products.

Studies at the USDA Agricultural Research Service center in Peoria, IL, show that starch can be blended into plastic films that may serve as biodegradable mulches for tomatoes and other high-value crops. "We are working on new formulas for mulches that micro-organisms can break down after a crop is harvested," says chemist Felix Otey.

This feature preserves the environment and saves the expense of having to remove and burn or bury the mulches.

Home gardeners and farmers use plastic mulches to protect crops from weeds and drought and extend the growing season by warming the soil sooner in the spring. And farmers use them to produce an earlier crop that commands a good price.

An estimated 285 million pounds of petroleum-based plastic film was produced in 1983 for agricultural use, according to an industry spokesman at a National Agricultural Plastics Association meeting. About 125 million pounds of that plastic was used for mulching. Total film production was projected at 423 million pounds by 1990, but Otey suggests the projection may prove too conservative as technology advances.

Starch-plastic blends have other potential applications. They could serve as wrappings for foods and other consumer items. They can be made into semipermeable membranes—films that allow small molecules in a mixture to pass through them while retaining larger molecules. These membranes could serve a myriad of uses, such as separating toxic substances from blood in artificial kidneys and recovering lye used in manufacturing rayon.

Research started more than a decade ago by Otey and colleagues led to the only starch films produced commercially thus far: water-soluble laundry bags for use in hospitals. These bags can be sealed and placed directly into the washing machine where they dissolve, protecting hospital staff against the danger of contamination from soiled linens.

Until now, other markets for starch films have not developed, probably because the formulations resulted in films that were too weak and had too many tears and other flaws. Industrial processes that turn out hundreds of feet of film per minute require a uniform, continuous film.

About 125 million pounds of petroleum-based plastic film was used for agricultural mulches in 1983.

—National Agricultural Plastics Association

Last year, a commercial firm ran one of Otey's new formulations through a film-blowing machine without any major problems. About 45 percent of the new formulation was ethylene acrylic acid (EAA) polymer, a compound that imparts uniform composition and strength to the film.

Using the recent technical advances, starch films could probably be produced and marketed at prices not much higher than prices for pure plastic ones, says Otey. And the difference could be offset by savings from not having to dispose of the mulch after use.

In a scenario in which costs of petrochemicals rise and price of corn remains depressed by surpluses, starch-plastic films may become more competitive with conventional films.

As of September 1, 1986, the nation had a surplus of about 2.5 billion bushels of corn. The oversupply is expected to grow to 3.5 billion bushels by the fall of 1987.

From Soybeans to Plastics

Scientists foresee potential new uses for soybeans and other vegetable oil crops as changing economics lead to adoption and refinements of research developments at the Northern Research Center.

Vegetable oils are candidates for alternative fuels for diesel engines, but they are too viscous, or syrupy, for direct use, says chemist Arthur W. Schwab. Having conducted research to overcome this problem, Schwab patented a method to use microemulsions of water and alcohol dispersed in vegetable oils as diesel fuel. And using another approach, chemist Bernard Freedman has chemically modified soybean oil to a fuel and a byproduct, glycerol.

Glycerol is also a common byproduct of both animal and vegetable fat processing. Someday, bacteria may play a role in converting abundant supplies of glycerol to acrylic plastics.

Chemical engineer Patricia J. Slininger of the Northern Research Center has cited the bacterium *Klebsiella pneumoniae* as a candidate for that role. In fermentations, it feeds on glycerol.

K. pneumoniae produces 3-hydroxypropionaldehyde (3-HPA) that converts to acrolein. Acrolein can be used to make synthetic polymers, building blocks of such diverse products as clothing, acrylic plastics, pharmaceuticals, and paints.

Acrylic acid derived from acrolein and used in some of the products is worth about 60 cents per pound. Billions of pounds are produced each year, and each pound is made from about 3 pounds of petroleum.

Slininger and microbiologist Rodney J. Bothast found that in batches of fermentation broth *K. pneumoniae* can convert up to 84 percent of glycerol into 3-HPA, the parent compound of acrolein and acrylic acid. They and James E. Van Cauwenberge have patented the process. *(See page 16.)*

Could the research quickly lead to added value for surplus farm commodities? "That's not likely soon because the economics of replacing petroleum-derived acrylic acid are not yet favorable," says Bothast. "But when the time is right, what we have learned will be ready and waiting for commercial use, with some technical refinements."

Chemical engineer Pat Slininger draws sample of fermentation broth from biostat fermenter, an instrument which can convert glycerol to compounds used in manufacturing synthetic polymers. (0986X1020-7)

Looking into their crystal ball, the scientists foresee starchy farm products such as grain or cellulosic products such as cornstalks also serving as raw material for acrylic plastics. There are micro-organisms that produce glycerol during the fermentation of these materials to alcohol, Bothast says.

Bothast's research group is conducting basic research on the microbiology, physiology, and genetics of micro-organisms involved in fermentation. What they learn may someday have application in enzyme technology and biochemical engineering aimed at increasing the efficiency of meat and milk production and converting agricultural commodities into new and improved products.—**Ben Hardin, ARS.**

The scientists mentioned in this article are at the USDA-ARS Northern Research Center, 1815 North University, Peoria, IL 61604. ■

TECHNOLOGY

X-Ray System Finds Contraband Fruit, Plants

The airline passenger insisted that the cardboard box he was carrying didn't have any food in it.

But the agricultural inspector responsible for nabbing contraband foods and plants before they get any farther than the agricultural checkpoint at San Francisco International Airport, wasn't so sure.

Earlier, this box—and hundreds of others parcels and suitcases from incoming planes—had been tagged and routed through an experimental video, X-ray, and computer system that was specially programmed to detect food in luggage. The tag on this particular box indicated that "food shapes" had been spotted inside it and that it should be searched.

The inspector turned to a TV screen and called up from the computer's memory the X-ray image of the box taken a half-hour earlier.

With this, she knew exactly where to look inside the box and what to look for. Her find: A bag full of mangoes. She sliced one open and found the wriggling, wormlike larva of a mango seed weevil.

The passenger left without the fruit and with a warning against trying to smuggle illegal food into the country. He wasn't fined, but he could have been. The U.S. Government has collected more than $1 million in agricultural fines since 1984.

In this and similar instances, the experimental system showed its ability to help agricultural inspectors quickly and easily locate forbidden foods in the stream of suitcases, duffle bags, boxes, and parcels passengers bring with them from overseas flights.

So far, tests this past summer at San Francisco's airport turned up such illegal items as coconuts, dried orange peels, fresh mangoes hidden in large tin cans, and partially cooked duck eggs, according to the system's developers, chemist Thomas F. Schatzki and engineer Richard Young. Both are with USDA's Agricultural Research Service at the Western Research Center in Albany, CA.

Tests of the X-ray detection system this past summer at San Francisco's airport turned up such illegal items as coconuts, dried orange peels, fresh mangoes hidden in large tin cans, and partially cooked duck eggs.

Thomas Schatzki of ARS, seated at his X-ray device for detecting contraband fruit, marks a bag for inspection while U.S. Customs officer Don Patchen checks it for weapons and other illegal items. (0886X1003-21)

The system, developed for USDA's Animal and Plant Health Inspection Service (APHIS), could streamline manual inspection by—

- Alerting inspectors to those bags that need to be searched by hand, and thus eliminating the need to hand-search hundreds of other bags that are free of contraband.
- Showing where in these bags passengers might have packed the food.

Certain unprocessed foods and plants from other countries are banned in the United States because they may contain foreign insects or disease organisms that could wipe out American crops or livestock. The confiscated duck eggs, for example, might carry Newcastle disease, deadly to poultry. Orange peels might harbor citrus canker that could infect U.S. citrus groves.

Schatzki says the patented system

uses off-the-shelf digital X-ray equipment, a video monitor, and computers to find contraband. Here's how it works:

As luggage is unloaded from a plane, it is given a numbered tag, then routed past X-ray equipment that creates a picture of what's inside the bag. This X-ray image is fed to a TV screen and to a computer, where it is instantly analyzed and stored.

The computer is programmed to recognize what Schatzki describes as "food shapes." Specifically, the computer can readily locate the circular cross-sections that almost unfailingly distinguish food and other agricultural items from manufactured objects (which usually have rectangular cross-sections).

On the TV screen, any food shapes recognized by the computer are instantly highlighted by a brightly colored outline.

At that point, the numbered tag on the suspect luggage is specially marked. Later, when the traveler picks up the luggage and takes it to the checkout stations, the code will alert other inspectors that the luggage must be hand-searched.

"The video and X-ray can scan the bags at the rate of about one bag every 3 seconds," Schatzki says. "The computerized system could cut the time passengers spend waiting in line and still give APHIS inspectors at least a glance in every bag."—By **Marcia Wood,** ARS.

Thomas F. Schatzki and Richard Young are at the USDA-ARS Western Research Center, 800 Buchanan St., Albany, CA 94710. ■

Test for Spoilage in Liquid Eggs

Food inspectors rely mostly on odor to tell if liquid eggs, used for commercial baking, are spoiled. Now food quality scientists have found a chemical test to detect spoilage.

An analytical process, chromatography, measures two chemical substances that are present at higher levels in spoiled liquid eggs, says Cletus E. Morris, a chemist for USDA's Agricultural Research Service.

Morris and Mona L. Brown, also a chemist at the agency's Southern Research Center in New Orleans, LA, found that if the two chemicals—dimethyl sulfide and uracil—are at higher-than-minimum levels in liquid eggs, inspectors usually find the eggs unfit to eat.

Morris says results to date indicate that the new test offers a precise, objective way to monitor liquid eggs, "especially when they are just on the verge of spoiling. At that point, inspectors may not be able to smell the odor even though the eggs are beginning to spoil."

Liquid eggs are removed from shells at processing plants and shipped in bulk on refrigerated tank trucks. They are used as ingredients for baked goods, custards, and other foods. The new test would not be used for eggs in their shells.

In addition to checking for spoilage by evaluating odor, inspectors at egg-processing plants routinely screen eggs by using bacteriological tests, Brown says.

The new test, if confirmed by further evaluation, would be a faster and simpler way to detect spoilage and could be adapted for on-the-spot use, Morris says. He and Brown did the research in the center's food flavor quality laboratory.

They used two types of chromatography—liquid and gas—to check egg batches. Morris relied on the liquid form to analyze whole eggs and yolk samples for uracil, an odorless chemical compound. Brown used gas chromatography to detect dimethyl sulfide, a volatile substance, in samples of whole eggs, yolks, or egg whites.

Dimethyl sulfide is a liquid found in a number of natural products. In trace amounts, it can give a desirable flavor, but in large amounts it may contribute to the smell of the spoiled eggs. The researchers say that it is not known what causes the higher amounts of dimethyl sulfide and uracil in spoiled liquid eggs.—By **Sean Adams,** ARS.

Cletus E. Morris and Mona L. Brown are at the USDA-ARS Southern Research Center, P.O. Box 19687, New Orleans, LA 70179. ■

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

PATENTS

Plant Fiber Additive for Food

See "Brownies With Fewer Calories," p. 5. *Patent Application Serial No. 06/809,803, "Modified Plant Fiber Additive for Food Formulations."* ■

Turning Surplus Crops Into Plastics

See "Farm Surpluses: Sources for Plastics," p. 13. *Patent No. 4,454,268, "Starch-Based Semipermeable Films"; Patent No. 4,337,181, "Biodegradable Starch-Based Blown Films"; and Patent Application Serial No. 894,140, "Production of 3HPA From Glycerol by* Klebsiella pneumoniae." ■

Detection of Agricultural Contraband

See "X-Ray System Finds Contraband Fruit, Plants," p. 14. *Patent No. 4,539,648, "Detection of Agricultural Contraband in Luggage."* ■

Computerized Windmills

Wind-driven generators or alternators can generate 29 to 47 percent more power with this computerized control system than machines with older control methods.

The new system makes adjustments to maximize electricity production based on the output voltage of the generator. (Output voltage is related to the rotational speed of the generator and thus to windspeed.)

A sensor periodically samples the output voltage while a computerized control increases voltage to the generator field coils a step at a time. After each increase, the computer checks to see if overall output is still going up. As soon as the output starts to decrease—such as with a drop in windspeed—the computer lowers the field voltage step by step to keep electrical output as high as possible for the available wind.

In this way, the computer responds to changes in windspeed, giving the turbine maximum performance.

Another sensor measures windspeed directly, to turn off the turbine if there is too little wind to operate efficiently or if speeds become dangerously high.

Patent Application Serial No. 06/680,615, "Output Responsive Field Control for Wind-Driven Alternators and Generators." ■

Detecting Immunoglobulins in Swine

An Agricultural Research Service scientist has developed an accurate way to detect and measure swine antibodies—proteins that transmit immunity to offspring.

This discovery has implications for human research because pigs are research models for similar immune systems in people.

Detection of these proteins, immunoglobulins (Ig's), also holds considerable potential for diagnosis of swine diseases. This detection method uses monoclonal antibodies specific to each of three major types of Ig's (IgM, IgG, and IgA). IgM is the first and main Ig produced by a pig's immune system to ward off a disease. As the attempt to fight infection progresses, IgG is produced and the IgM level goes down. The ability to identify and measure amounts of IgM could therefore be useful to distinguish current from past infections. Antibodies to IgA will provide tools for detecting Ig's in secretions and be useful in studies on immunity to enteric (small intestine) pathogens.

Patent No. 4,468,346, "Monoclonal Antibodies to Porcine Immunoglobulins." ■

How To Obtain a License for USDA Patents

For technical information on patents listed on this page, contact researcher or Coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705.

If you are interested in applying for a license on a patent, or receiving a catalog of USDA patents, write to the Coordinator.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

34/10

U.S. Department of Agriculture Agricultural Research Service Vol. 34, No. 10, November/December 1986

Agricultural Research

NEWARK PUBLIC LIBRARY
DEC 22 1986

Ozone Robs Yields

Story on page 6.

A77.12:

Research: Starting Point for Action

Many agencies, both public and private, share the responsibility for protecting America's supply of food and fiber from field to table. At the federal level, these organizations are usually called action agencies, because they carry out specific programs to eradicate an insect pest, to control soil erosion, or to ensure quality and safety of agricultural commodities.

Examples of action agencies within USDA are the Animal and Plant Health Inspection Service, Federal Grain Inspection Service, Food Safety and Inspection Service, and Soil Conservation Service. Each is supported in its mission by the nation's largest agricultural research organization—the Agricultural Research Service. We have no more important responsibility than to conduct research for these action agencies. Our task is to help solve problems that may deter them from achieving their goals. It is in this way that we best serve farmers and ranchers and consumers.

To carry out our mission, ARS employs some 2,700 scientists at 137 locations in the United States and abroad. Entomologists, soil scientists, chemists, agronomists, and representatives of more than a score of other scientific disciplines are seeking—and finding—answers that the action agencies can put to practical use.

More often than not, ARS research undergoes trials in the field, in cooperation with the action agencies and often with state agencies, universities and experiment stations, farmers and ranchers, and industry.

Results from these cooperative relationships have gone a long way toward solving many serious problems, such as:

- *The screwworm fly.* When this costly pest infested American livestock in the South and Southwest, an ARS scientist devised an original way to eradicate it: turning the screwworm's reproductive ability into a weapon. Billions of male flies sterilized by radiation were released to mate with native females, each of which mates only once. The sterile males so outnumbered native males that few offspring were produced. The procedure was repeated until the screwworm was gone from the United States. Today the battle continues in southern Mexico.
- *Africanized bees.* These aggressive bees, expected to reach Texas and Arizona by 1988-92, produce little honey and are more likely to sting than European strains common in the United States. ARS has developed easy-to-use identification tests so field technicians can distinguish Africanized bees from other strains. ARS is working with Animal and Plant Health Inspection Service experts to develop a barrier zone in Mexico to stop them from spreading into the United States. This barrier plan will include trapping bees, baiting hives to kill Africanized swarms, close monitoring and inspection of hives, and other measures.
- *The boll weevil.* This cotton pest has been largely eradicated in the Carolinas by an ARS-developed insect control technology—a combination of traps, pesticides, and other practices. The program may be extended to other cotton states as well.
- *Trichinosis in swine.* Our scientists have developed a blood test that detects this parasitic disease in pigs with 95-percent accuracy.
- *Grain quality.* ARS developed rapid methods for measuring protein content and hardness of wheat, a key to grading and pricing. We have also pioneered the use of in-transit fumigation of U.S. grain destined for foreign countries.
- *Food safety.* ARS is studying sodium (a component of table salt) and nitrites, two substances used to control food-poisoning bacteria. Since these substances have recently raised health concerns, our scientists are studying how much sodium and nitrite can be removed without allowing bacteria to grow. And to help the meat industry and federal regulators ensure product safety, we have developed guidelines on cooling requirements for meat and on time and temperatures for thawing red meat. These precautions will also help industry and consumers control the growth of bacteria that could cause food poisoning.
- *Wind and water erosion.* Research includes developing a better understanding of how erosion affects production and how conservation tillage affects the soil environment. Also in the works are improved equations for predicting soil erosion.

By working together on these and other problems, we help USDA action agencies carry out their mission of protecting our food and natural resources.

Terry B. Kinney, Jr. Administrator

Agricultural Research

Cover: ARS plant pathologist Allen Heagle (right) and Walter Pursley discuss progress of study on air pollution's effects on soybeans. So far, they've found that the more soil moisture there is the more ozone plants absorb. Story begins on page 6. (0986X1055-25A)

p.10

p.12

p.4

6 Research Assesses Ozone Damage to Crops

Ozone and other air pollutants cost farmers at least $1 billion in agricultural crop losses each year, scientists say.

8 Animal Electronics Make Cows Bionic Bovines

Implanted transmitters keep tabs on weight and health of cattle roaming the range.

11 Senepol: New Strain for Subtropical Herds

A beef cattle from the Caribbean may become a desirable addition to breeding programs from Texas to the Carolinas.

12 Computer Keeps Potatoes Breathing Freely

Proper ventilation is the key to disease-free storage.

DEPARTMENTS

4 AgNotes:

Corn's Wild Cousin Undergoes Sex Change
CAT Scanning Farm Animals
Test-Tube Intestines
More Beef Per Acre

14 1986 Index

16 Patents:

A Tidy Way To Plant and Fertilize
Colorful Cotton

Vol. 34, No. 10
Nov./Dec. 1986

Editor: Lloyd E. McLaughlin
Associate Editor: Donald L. Comis
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Daniels
Art Director: Deborah Taylor

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley
Assistant Secretary
Science and Education

Terry B. Kinney, Jr.
Administrator
Agricultural Research Service

Corn's Wild Cousin Undergoes Sex Change

A wild relative of corn called eastern gamagrass has undergone a sex change that could offer farmers a new grain crop.

In one variant of the gamagrass, male flowers have turned female and started doing what female flowers do best—producing seed.

"Our research here shows that with both the male and female parts producing seed, production on each seed head has increased by about 2,500 percent," says Chester L. Dewald, a USDA Agricultural Research Service agronomist in Woodward, OK.

Because eastern gamagrass seeds have protein—even more than corn—it could become a nutritious grain crop to be eaten by both livestock and people.

Eastern gamagrass, which flourishes in the southeastern states and Mexico, is a bunchgrass ranging in color from green to brown. It can grow 6 to 8 feet tall.

Dewald says, "We have a long way to go before we finish breeding the grass for human or livestock use, but it can definitely be done."

He has already bred a gamagrass line that produces twice as much seed as the original variant.

The variant, whose stalk and leaves resemble those of corn, originally showed up in a nursery at the Plant Materials Center of the USDA Soil Conservation Service in Manhattan, KS. Robert Dayton, who was manager of the center at the time, had planted what he thought were normal eastern gamagrass seeds. When the plants grew, he recognized that one of them was very different from the rest and contacted Dewald at the Southern Plains Range Research Station.

Agronomist Chester Dewald inspects seed heads of eastern gamagrass variant. (0686X737-9)

Dewald later found the variant growing in the wild in Ottawa County, KS.

"We think the mutation is a throwback to when all flowers on the plant performed both functions," Dewald says. The gene or genes that "ordered" all parts to do both jobs had been lying dormant for years and just began controlling the plant again.

Dewald adds that the discovery may reveal the secret behind corn's evolution. "Close relatives often undergo similar mutations, so perhaps this indicates that corn changed into a prolific grain producer in one step, with one mutation."

Confirmation of Dewald's suspicion could rewrite chapters of evolutionary botany, because scientists have traditionally thought corn's transformation into a prolific grain producer was very gradual, over thousands of years.—By **Jessica Morrison,** ARS.

Chester L. Dewald is at the USDA-ARS Southern Plains Range Research Station, 2000 18th Street, Woodward, OK 73801. ■

CAT Scanning Farm Animals

A sophisticated tool used in human medicine may help select livestock of the future with just the right amount of fat for consumers.

Kreg A. Leymaster, an animal geneticist with the USDA Agricultural Research Service in Nebraska, believes the CAT (computer-assisted tomography) scan may be just the tool for livestock scientists.

Preliminary results from experiments Leymaster helped conduct at the Agricultural University of Norway "are quite encouraging," Leymaster says.

CAT scanners are commonly used in medicine as a diagnostic tool. The cross-sectional images, constructed from X-ray data, may provide animal researchers a way to assess the amount of lean meat without slaughtering the animal.

Leymaster says, "After seeing inside the living animals in this way, researchers can save for breeding those animals judged as genetically superior."

The goal is to produce meat that is lean as well as tender and tasty.—By **Ben Hardin,** ARS.

Kreg A. Leymaster is at the Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, NE. 68933 ■

Test-Tube Intestines

Thin sections of pig intestine can now be kept alive and functioning in test tubes for 5 days or more after being removed from the animal.

This feat offers new insights on how intestines respond to viruses, drugs, toxic materials, and the first milk (colostrum) that mammals produce after giving birth.

Phletus P. Williams, a USDA Agricultural Research Service microbiologist at the National Animal Disease Center, Ames, IA, developed the technique. Before now, no intestinal organ samples from people or animals have been kept in good condition for more than 3 hours.

A key feature of Williams' technique is alternating between rinsing the tissue and exposing it to a carbon dioxide-air atmosphere. The rinse solution contains nutrients and antibiotics. The sample is rotated in a glass tube 12 times per hour.

Williams places a section of the intestine, inside out, over a rectangular surgical sponge. This positioning enhances cleaning of the intestine's mucous membrane by the gentle rinsing. The rectangular shaping helps the researcher locate sites for detailed examinations through scanning and transmission electron microscopes. Morever, the inside-out orientation means the cell lining of the intestinal tract can then be observed easily and the penetration, movement, and effects of test materials can be checked.

"Such observations are difficult or impossible in an intact animal," Williams says.

In addition to studies with viral pathogens that cause transmissible gastroenteritis (diarrhea) and pseudorabies, Williams has demonstrated for the first time the moving of colostral cells through the lining of intestines taken from newborn pigs.

Colostrum, which passes from the gastrointestinal tract to the bloodstream of a newborn, is composed of secretions formed in the sow's mammary glands before normal lactation. It is packed with proteins, vitamins, and antibodies.

Williams exposed different sections of intestine to colostrum he had treated with a fluorescent marker and examined them under a microscope. He determined that the first and second divisions of piglet intestine transport colostral cells through to the bloodstream for about 24 hours after birth. Then the intestinal lining thickens and prevents cell transport.

Pigs, unlike people and some animals, do not receive antibodies before birth from the mother through the wall of her uterus.

Because the first milk is so critical to the survival of piglets, Williams says, knowing how and when colostral cells and antibodies move into the bloodstream may lead to new methods for preventing deaths among newborn pigs.—By **Ben Hardin,** ARS and **Ray Pierce,** ARS (retired).

Phletus P. Williams is in Virology Swine Research, USDA-ARS National Animal Disease Center, P.O. Box 70, Ames, IA 50010. ■

More Beef Per Acre

Cattle are smart enough to know when it's time to switch from old grass to the feeding trough. This self-regulating ability can be exploited by farmers who want to feed more animals per acre.

Cattle on bermudagrass pasture are observed by animal nutritionists William Phillips, ARS, (left) and Gerald Horn, Oklahoma State University. The number of cattle per acre is varied to determine the most efficient system for producing beef. (0786X771-4)

Of course, before farmers can decide whether to do this, they'll need to know how much it's going to cost them in extra feed.

Information on feed costs is especially critical to those farmers in the Southern Great Plains who keep cattle from about June 1 through October 1—the growing season of pasture grasses such as bermudagrass.

With these farmers in mind, animal nutritionists William A. Phillips, Agricultural Research Service, and Gerald W. Horn, Oklahoma State University, ran a 5-year study of steers grazing bermudagrass.

They tested three levels of grazing—the equivalent of two, three, and four 500-pound steers per acre. In all three systems, the nutritionists provided supplemental feed when bermudagrass was limited during the 4-month grazing season each year.

They found that the system with the fewest animals per acre, a low-risk system, pretty much guarantees farmers that they can depend on grass to provide all the feed. If it's a good rainfall season they even have enough grass for a hay crop. That's why most farmers choose this system—it's the safest way to go in the semiarid plains of Oklahoma and requires no additional feed inputs with additional cost.

But the nutritionists found it's not the most efficient way to produce beef because it wastes good quality grass. The medium-risk (3 animals/acre) and high-risk (4 animals/acre) systems make for more nutritious forage because they keep the grass in a constant regrowth stage, rather than letting it mature to a poorer quality forage.

These systems do maximize the utilization of the grass but require supplemental feeds which can be purchased or grown by the producer.

The success of the higher risk systems and the protection of the pasture depended on the availability of supplemental feed.

Finding out how much silage was needed required a trial-and-error method and some waste of silage at first, but now with all the data in, the scientists can tell farmers how much extra feed steers will eat—on a daily basis—and how much weight they will gain.—By **Don Comis,** ARS.

William A. Phillips is at the USDA-ARS Forage and Livestock Research Laboratory, El Reno, OK 73036. Gerald W. Horn is at Oklahoma State University, Stillwater, OK 74078. ■

Research Assesses Ozone Damage to Crops

Ozone and other air pollutants are costing farmers at least $1 billion in agricultural crop losses each year, according to Agricultural Research Service scientists studying the damage.

"Farmers don't see ozone damage happening to their field crops, but it is," says Walter W. Heck, a plant physiologist who heads the agency's air pollution research at Raleigh, NC, in cooperation with the Environmental Protection Agency (EPA).

Damaging ozone is caused by a photochemical reaction of sunlight with automobile and industrial exhausts containing nitrogen oxides and hydrocarbons. It is different from the ozone layer in the Earth's stratosphere that filters out ultraviolet sunlight but does not harm crops.

"Ozone is carried by prevailing winds, often for hundreds or thousands of miles," Heck says. "That's why rural areas, despite having fewer automobiles and industrial plants, often equal the ozone pollution levels for urban areas."

As a result, he says, crops far away from pollution sources are not necessarily safe from ozone.

"We see in field-test chambers and in greenhouses that ozone is causing leaves of soybean, wheat, cotton, peanut, and other agricultural crops to die prematurely, reducing yields and costing the farmer money," he says. "And the $1 billion figure doesn't include damage to horticultural crops and to forests."

Yield losses are based on crop studies done at sites across the country from 1980 to 1982. Findings from 1983 to 1985 are being analyzed, Heck says, and final results are expected in 1987.

Heck's laboratory has been studying the problem since 1980 as part of the National Crop Loss Assessment Network (NCLAN), set up by EPA to get estimates of agricultural crop losses from ozone and other air pollutants.

A typical long-term concentration, or level, of surface ozone is 0.05 ppm, Heck says. In test areas, ozone levels ranged from about 0.04 to 0.06 ppm during a 7-hour day, from 9 a.m. to 4 p.m.

Indoor chambers control environment of snap bean plants to test response to ozone under various conditions. Plant physiologist Walter Heck and botanist John Dunning review records. (0986X1056-6)

"Ozone is carried by prevailing winds, often for hundreds or thousands of miles. That's why rural areas often equal the ozone pollution levels for urban areas."

—Plant Physiologist **Walter W. Heck**

That level can significantly damage crops when plants absorb it over an entire growing season. Among the yield losses assessed to date in the NCLAN studies:

- Soybean yields decreased 12 percent when exposed to 0.05 ppm of ozone in 1980-82 field tests at Argonne, IL, Beltsville, MD [see *Agricultural Research*, November 1981, pp. 4-6], Ithaca, NY, and Raleigh.
- Peanut yields also decreased about 12 percent during 1980 tests at Raleigh. Peanut and soybean losses

Technicians Tommy Gray and Gwen Palmer check equipment that dispenses ozone and other gaseous pollutants into an adjoining greenhouse. (0986X1056-20)

Acid rain's about to fall on test plants. Gwyn Trueblood adjusts curtains to keep plants from being splashed by neighboring showers. Tabletops rotate to ensure equal doses during simulation. (0986X1056-30)

were among the highest for crops tested.

- Cotton yields at Shafter, CA, showed a 7-percent reduction, while 1982 tests at Raleigh showed that yields of a common type of cotton grown in the South decreased by 10 percent.
- Winter wheat yields at Argonne were reduced 7 percent.
- The lowest reduction at 0.05 ppm was 1.5 percent in corn tests at Argonne in 1981 and for sorghum there in 1982.
- As ozone increased, yields declined for all the crops tested. At 0.06 ppm, for example, soybean yields were cut by 17 percent, and at 0.09 ppm, the loss was 31 percent.

The results for soybeans, cotton, winter wheat, and corn were calculated on what Heck calls a "common ozone response" of several varieties for each crop. The peanut and sorghum results were based on data from a single variety for each crop.

Heck and agency plant pathologists Richard A. Reinert and Allen S. Heagle at Raleigh are studying ozone and other air pollutants in several ways. Heagle conducts outdoor field studies in specially designed test chambers; Reinert conducts indoor studies in exposure chambers placed in greenhouses and in a building called a phytotron, where environmentally controlled rooms and compartments allow scientists to study the problem under a variety of conditions.

"We study plants at different stages of development and expose them to different factors to see what ozone does to them," says Reinert. "In the greenhouses and phytotron, we can see how temperature, light, fertilizers, moisture and other variables affect a plant's response to ozone and other air pollutants. We can also determine how other factors such as plant diseases are influenced by air pollutants."

The outdoor studies are in cylindrical, open-top chambers specially designed to gauge the effects of air pollutants on different crops.

The chambers are 10 feet in diameter and 8 feet tall, with aluminum frames surrounded by plastic. They are placed on the ground, and crops are planted inside of them. Air is pumped into them, either through charcoal filters to remove ozone, or without filters to let ozone in.

Ozone in the different chambers can be regulated so that scientists can compare plant responses at various concentrations or when ozone is filtered out.

"We've only scratched the surface at this point," Heagle says, "but we're at the point where the trends we've seen are pretty clear. Now we want to continue studying how moisture affects a plant's response to ozone. We've only done that for the past 3 years."

Moisture plays a key role, according to Heck. When a plant lacks water, its stomates, the openings in its leaves, close to retain water in the plant. This, he says, reduces the amount of ozone a plant absorbs through the stomates from the air.

"This may explain, in part, why ozone appears to affect plants more in the East, where there is more rain," Heck says. "They probably absorb more ozone, whereas in the West, drier conditions may help plants cut down on the amount of ozone they absorb—unless they are irrigated."

Ozone enters a plant as its leaves absorb carbon dioxide necessary for photosynthesis, in which plants use sunlight to form carbohydrates. When damaged by ozone, a plant's leaves age prematurely and discolor, leaf cells die, and photosynthesis and growth decrease.

"It is frustrating for growers that we don't have anything really simple to tell them that they can do about ozone pollution," Heck says.

One research option is to breed plants that have genetic resistance to ozone, he says. "Such resistance apparently exists in all crop species that have been examined."

Meanwhile, the national crop network is completing a series of field studies and will hold an international conference in Raleigh in late 1987 to discuss results and ways to deal with air pollution problems.—By **Sean Adams,** ARS.

Walter W. Heck is in USDA-ARS Air Quality Plant Growth and Development Research, Raleigh, NC 27695. ■

Animal Electronics Make Cows Bionic Bovines

Farmers and ranchers may soon electronically monitor their livestock just as routinely as computers now monitor engine functions in some modern automobiles.

Already, some dairy farmers have installed computer-controlled devices that automatically meter feed to cows based on their individual milk production records. This ensures that high-producing cows get more feed than low-producing ones.

Roger J. Gerrits, National Program Director for Animal Production and Protection, USDA Agricultural Research Service, Beltsville, MD, says, "Scientists and commercial firms are currently developing and testing several devices for research or use on farms or in animal- and food-processing plants. The sensing and imaging technology has moved very rapidly in the last 10 years. Many devices have been developed for diagnosis and early detection of human diseases, and several of these are now available for animal research at considerably reduced cost."

"Electronic sensors are being used to measure animal weight, carcass composition, body temperature, and fertility. We will see tremendous progress in the next 5 years in the use of sensing technology for animal identification, diagnosis or detection of diseased tissue, and the refinement of current methods that will permit electronic analysis of meat. Commercial animal- and food-processing plants will use the technology to identify quality and composition of meat."

For consumers, the new technology will ensure the quality and safety of meat products.

For producers, the technology will mean an equitable price for the delivery of high-quality products and will reduce cost of production. For example, electronic monitoring of livestock may cut losses farmers now experience due to late detection of illnesses.

Also, electronic sensors can measure an animal's weight gain from miles away. For the beef producer, rapid weight gain is of paramount economic importance. Farmers and ranchers who know which animals are lagging behind others can take steps to treat them if they are sick or cull them from the herd if they are inferior producers. Not only would culling eliminate inefficient gainers, it would help ensure that only superior genetics pass to the next generation.

Animal physiologist Gregory Lewis (seated) and biological technician Douglas Caldwell test a sensor held by Caldwell that will detect when this cow is ready to give birth. (0886X976-21)

But weighing livestock, especially on open ranges, is time consuming and expensive. Cattle have to be herded into pens and driven onto scales. The extra handling upsets livestock and can disrupt a research project.

In May 1986, ARS scientists at Miles City, MT, started testing an electronic system that automatically weighs cattle every time they come for water.

When a thirsty cow enters a small enclosure containing a water basin at the opposite end, she breaks a light beam. Much like the door operation in some grocery stores, the beam controls a gate that shuts automatically behind her. Once she is locked in the stall leisurely drinking water, the electronics go to work.

Each cow has a donut-shaped ear tag about the size and thickness of three stacked quarters. As she lowers her head to drink, the ear tag comes close to a box that emits low-level microwaves. This energy bombards the ear tag, bringing to life a miniature radio transmitter inside that broadcasts her identification number. After this ID is verified by a microcomputer, the time and date are recorded and measuring begins.

The bottom of the stall is a scale. The cow's weight is read electronically 30,000 times a second. An average of these weights, computed each second, eliminates variations caused by the cow jostling around—something similar to weight differences people can get by shifting their bodies on bathroom scales.

Other devices measure volume and weight of water each cow drinks. When the cow has finished, she starts to back out of the stall, breaking another light beam that triggers the release mechanism on the privacy gate. She returns to her pasture, and the microcomputer calibrates the scale, setting it to read zero just before the next cow enters. This eliminates errors that might occur if cows track in mud or defecate. The scale also has heating coils to keep snow or ice from accumulating in cold weather.

Researchers, 5 miles away in an office at the Fort Keogh Livestock and Range Research Station, receive the data via radio. A computer stores this data for analysis and gives information on how individual animals are faring on the range as well as overall herd performance.

Bradford W. Knapp, a statistician at the research station says, "We use repeaters that pick up the electronic signals from our seven scales, amplify their intensity, and boost them over hills that make line-of-sight transmission impossible. With more repeaters, we could collect information from the very edges of our 55,000-acre experimental ranch—some 8 miles distant."

"Our system is 'water driven,' meaning the cow's reward for entering the stall is a drink. It can be modified so the treat is a feed supplement when the research requires it," says Don C. Adams, a range nutrition scientist.

> ***"We will see tremendous progress in the next 5 years in the use of sensing technology for animal identification, diagnosis and detection of disease..."***
>
> —**Roger J. Gerrits,** National Program Director for Animal Production and Protection

Adams and another range scientist, Pat O. Currie, are using the new equipment to monitor cattle gains on eight summer pastures that have received various treatments to improve grass growth. Currie developed the pastures with a machine that, in a single pass, can till, build water-retaining furrows with small dams, and apply fertilizer and seed. (See *Agricultural Research*, October 1983, pp. 8-9.)

The pastures obviously look better, Currie says, but the true value of rangeland improvement is how much faster cattle gain weight. In a study just begun, all pasture treatments are helping the cattle gain weight faster compared with regular pastures. Further studies will show which boosts weights the most. Then the scientists will be able to tell ranchers how they can improve their own cattle operations.

The weighing system at Fort Keogh is portable, and scientists intend to move it to winter pastures to check performance of cattle receiving supplemental feed. At the same time, Adams and Currie will study how harsh winter weather affects cattle. A weather station hooked to the remote weighing system automatically measures such things as temperature, barometric pressure, windspeed, and humidity.

In New Mexico, near Las Cruces, at the 193,000-acre ARS Jornada Experimental Range, another system is helping scientists monitor beef cattle growth on desertlike rangeland.

The Las Cruces scientists want to learn how much supplemental feed should be given livestock and when it is most helpful. This information will be useful to ranchers with similar rangeland in western Texas, southern New Mexico, and southeastern Arizona.

Cattle have a tough time getting enough to eat on arid rangeland. Each cow often has to graze 2 to 3 acres every day in the winter. And when there isn't enough rain in the fall and spring, there may be little or no green forage for them.

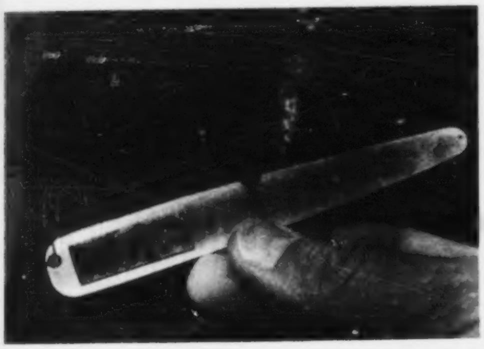
The scientists are using the equipment to electronically identify and sort about 100 head of cattle into 3 groups every time they come in for water. Two of the three groups receive cottonseed meal to supplement their range diet.

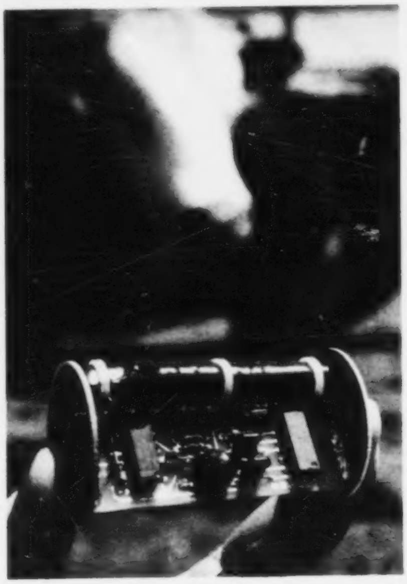
"By having the three groups graze the same range, we eliminate the effect different pastures might have on our results. Thanks to the electronic equipment, we can quickly and cheaply separate the groups at feeding time," says range scientist Dean M. Anderson.

USDA's Animal and Plant Health Inspection Service, in cooperation with the Los Alamos National Laboratory, Los Alamos, NM, developed the electronic identification system, and ARS scientists integrated it with an electronic weighing system.

Weights are not the only bovine secrets being exposed by ARS electronic surveillance—implanted electronic sensors have proven more than 90 per-

Animal Electronics Make Cows Bionic Bovines





Two types of electronic transponders identify the animals wearing them. One (top left) is implanted under the animal's skin. A similar unit (top right) is encased in plastic and worn around the animal's neck. Each contains a miniature radio transmitter that broadcasts an identification number to a computer. (Top left photo, 0586X576-27; Top right, 0586X575-33)

Above: Range scientist Dean Anderson reviews weights for beef cattle separated into three groups—two with supplemental feed and one without—collected as cattle move through the electronic weighing system. (0586X579-22)

cent accurate in detecting when cows are ready for mating.

The sensors also predict when cows will give birth. This will help cut cow and calf deaths. If farmers know when the calf is due, they can be present to assist in difficult deliveries.

In Maryland at the Beltsville Agricultural Research Center, biomedical engineer Alan Marc Lefcourt says, "The key to these sensors' operation is resistance of reproductive tissue to small electrical pulses, about one-twelfth of the 5-milliamp current used in most human heart pacemakers. When a cow is in heat, these tissues swell with water, making them less resistant to the current. This information is relayed electronically to a recording device."

Currently, dairy farmers must rely on cow behavior, such as restlessness, to signal that it's time for breeding. If dairy farmers miss these clues, which they do half of the time, it costs them money—an estimated $300 per year for each cow in the herd.

The sensors and monitoring electronics, if commercially mass-produced, coupled with a standard computer, shouldn't cost the farmer more than $30 per cow per year. The equipment cost is minimal compared with the expense of feeding an unproductive dairy cow 21 more days (the length of the estrous cycle) for each breeding time missed—and paying another breeding fee.

Gregory S. Lewis, an ARS animal physiologist in Beltsville, MD, and Eliezer Alzinbud, an Israeli scientist, cooperated in developing these sensors in a joint project supported by the U.S.-Israel Binational Agricultural Research Development Fund.

In Ames, IA, at the National Animal Disease Center, electronic engineer Joseph L. Riley has a sensor and radio transmitter to check stomach wall movements or contractions in cattle.

Riley says, "The unit is encased in a capsule small enough to be placed in the rumen through a stomach tube. It will broadcast readings on the rumen's response to feed toxins or to diseases for about 2 months, depending on the life of the batteries."

Animal electronic sensors coupled with computer technology have been largely research tools in the study of animal physiology and behavior to date, but the information gained will lead to practical uses for farmers and ranchers in the future.

"We can expect commercial interests to eventually offer some of these animal electronics to the livestock industry. The prices should fall just as we saw pocket calculators fall in price from several hundred dollars to sometimes giveaway sales gimmicks," says Gerrits. "There is little question that this equipment could become as commonplace on animals as electronic wristwatches have become on people."—By **Dennis Senft,** ARS.

Roger J. Gerrits is on the USDA-ARS National Program Staff, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■

Senepol: New Strain for Subtropical Herds

Senepol, a Caribbean breed of beef cattle that is relatively new to the United States, shows promise of becoming a desirable addition to breeding programs from coastal Texas to the Carolinas.

The placid cattle, which range in color from tan to dark red, were originally bred in 1918 on the island of St. Croix, in the U.S. Virgin Islands.

They were the result of a cross of Red Poll, an English breed, with N'Dama, a humpless longhorn from West Africa. The hornless, humpless breed that resulted—Senepol—adapted well to the island's tropical environment, tolerating ticks, insects, hot weather, and a wide range of rainfall.

They were able to graze through the hottest part of the day and maintain acceptable levels of production during dry spells.

Until the late 1970's, Senepol were largely confined to St. Croix. Since then, however, small numbers of Senepol have been imported into the United States, most of them to Florida and Tennessee.

Until the first Senepol-sired calves were born on USDA Agricultural Research Service property in Florida in 1978, all the cattle in this country that were adapted to life in the subtropics contained Zebu blood, a species *(Bos indicus)* with a characteristic hump. The most familiar Zebu representative to Americans is the Brahman, an ill-tempered animal that has been an irreplaceable part of every subtropical breeding program in the United States.

A different strain of cattle with similar adaptation, like Senepol of the *Bos taurus* species, should prove healthy for southern crossbred herds, bringing with it hybrid vigor as well as other desirable features, such as a gentle disposition.

USDA trials of Senepol cattle have been conducted since 1978 at the Subtropical Agricultural Research Station, a 4,000-acre ranch at Brooksville, FL, a few miles north of Tampa. The first research with Senepol at Brooksville was to determine whether the breed would transmit its tropical adaptation to a crossbred animal in a new environment. The study was carried out under the direction of Will T. Butts, an ARS geneticist, in cooperation with the University of Florida.

For his research project, Butts compared the performance of a crossbred Senepol-Angus herd with the more familiar Brahman-Angus crosses.

"Overall," says Butts, "performance of both crossbreeds under subtropical conditions was excellent." The tropical adaptation, he added, proved "definitely a genetic thing, with the adaptation mechanisms transmitted intact to the Senepol crosses, just as they have been to Brahman crosses."

Further, while the bahiagrass grazing around the station, "is anything but top quality feed," Butts says that weight gains of both crossbreeds, considering all the factors, have been "all that anyone could hope for."

Representative of a breed that is gentle, intelligent, and responsive to handling, a Senepol cow is a good mother, calving unassisted on the range and producing plenty of milk for fast weight gains. (0386X408-9A)

Other promising features of the Senepol crosses in a subtropical environment include good calf and milk production, an excellent record of unassisted calving, and early maturity. In St. Croix, a Senepol cow often produces 13 to 15 calves in her lifetime. Somewhat leaner than Brahman-Angus crosses, Senepol-Angus crosses produce carcasses of a slightly higher quality grade than those from the Brahman-Angus. Offspring weaning weights and carcass weights are similar for the two crossbred groups, indicating similar production efficiencies. (See table.)

Characteristics of calves and steers from Senepol-Angus and Brahman-Angus cows[1]

	Senepol-Angus	Brahman-Angus
Number calves weaned	21	22
Birth weight of calves (lbs)	74	69
Weaning weight of calves, adjusted to 205 days (lbs)	584	600
Cow weight at weaning (lbs)	1,087	1,143
Number of steers	9	7
Steers, days on feed	184	184
Steer carcass weight (lbs)	788	806
Steer carcass weight per 1,000 lbs. of cow weight	725	705
Steer carcass fat (inches)	0.45	0.52

[1] Calves sired by Simmental bulls. Performance of calves, born in 1984, is representative of that observed throughout the study. Source: Will T. Butts, Agricultural Research Service.

So far, reports Butts, only about 1,500 Senepol cows are registered worldwide, but counting calves, "the world population could be as high as 3,000 to 4,000."

"It's not a common breed," says Butts. "Not yet. But it's got a lot going for it."—By **Hubert Kelley,** ARS.

Will T. Butts is at the USDA-ARS Subtropical Agricultural Research Station, P.O. Box 246, Brooksville, FL 34298. ■

Computer Keeps Potatoes Breathing Easy

Agricultural engineer Lewis Schaper inspects vertical and horizontal air sampling tubes during bin-filling operation. (1086X1152-27)

When a 500 ton bin of potatoes is about to rot, storage managers need to take action in a hurry.

Now a new computerized system developed by USDA Agricultural Research Service scientists at East Grand Forks, MN, can give them a hand in deciding which action is best.

Researchers at the Red River Valley Potato Research Laboratory have linked a personal computer to gas monitoring devices, temperature and wind sensors, and ventilating fans to give early warning of spoilage or other storage problems.

The computer system helps most in controlling bin atmospheres during and soon after harvest. That's when potatoes recover from harvest damage and use large amounts of oxygen and produce high concentrations of carbon dioxide. Normal respiration in the dark conditions adds to a bin environment that promotes the outbreak of disease. "Disease micro-organisms love an anaerobic atmosphere where they have the advantage of living and growing without oxygen," says biochemist Jerry L. Varns.

Storage managers provide needed oxygen for the potatoes by forcing outside air into bins through ducts connected to an electric fan. Ventilation helps potatoes suberize, or cure. This process, which takes about 2 weeks, toughens potato skins and heals wounds inflicted by handling during harvest.

But the decision of how much ventilation to use is not as simple as it may seem. The bins used for potatoes intended for potato chips are typically 25 feet wide by 80 feet long. Potatoes are normally piled 16 to 18 feet deep in these bins. Excessive fan operation supplies "too much air too soon and causes them to shrink and flatten," says agricultural engineer Lewis A. Schaper. "Those on the bottom bruise from the weight of those above them."

Restricting air circulation too much can be harmful. Varns explains it this way, "Potatoes are alive. In storage they use up oxygen and respire carbon dioxide. The poor tubers on the bottom of the bin are the first to show breathing problems because of the weight stress. The added stress becomes too much and that's when diseases take

Above: Biochemist Jerry Varns evaluates potato storage environment by computerized monitoring of windspeed, temperature, relative humidity, and gases released by potatoes. (1086X1150-18)

Left: Research facility at the Red River Valley Potato Research Laboratory in Minnesota contains a single commerical-size storage bin holding over 1 million pounds of potatoes, enough to feed 10,000 people for a year. (1086X1154-3)

over. They start in small areas commonly called disease pockets and, if not contained, will quickly spread by the liquid generated in these pockets."

Varns says potato bins should have sufficient ventilation to keep carbon dioxide levels from rising above 2 percent during curing. After curing, levels should be kept even lower.

Experience in managing potato storages doesn't always provide the best insurance against disease problems. That's mainly because changes in temperature, humidity, and windspeed during harvest and bin-filling can create the need for individualized management for each bin. Such attention has not been possible for the majority of farmers who both grow and store potatoes.

After the researchers tested the computerized monitoring system in a commercial-sized research bin, they installed a second, modified system at an eight-bin commercial storage facility. Air samples from over 60 locations within the bins are automatically pumped via nylon tubing to a gas chromatograph for analysis.

The chromatograph acts as a mechanical nose by identifying key stress gases in the air much sooner than a human can detect them. Also, when carbon dioxide levels get too great, the computer turns on the fans to remove the heavy concentrations. Without ventilation, or if wind conditions are calm outside of storage buildings, accumulations can easily reach unfavorable levels of 4 to 6 percent. Conversely, windspeeds exceeding 10 mph can remove accumulations and the monitoring system turns off the fans. Computerized monitoring of each bin thus helps provide disease protection and minimize water loss from excessive ventilation.

Both laboratory research and fieldwork in commercial bins are being done in cooperation with the Minnesota and North Dakota Agricultural Experiment Stations and the Red River Valley Potato Growers' Association.—By **Linda Cooke-Stinson,** ARS.

Jerry L. Varns and Lewis A. Schaper are in the USDA-ARS Red River Valley Potato Research Laboratory, P.O. Box 113, East Grand Forks, MN 56721. ■

Gas Clues to Bruises

Excess carbon dioxide given off by bruised fruits and vegetables provides a telltale clue to rough treatment during picking and handling.

As a result, scientists can use carbon dioxide readings that are above normal respiration levels (for dark storage conditions) to quickly and reliably measure damage, says Clyde L. Burton, a plant pathologist with the USDA Agricultural Research Service in East Lansing, MI.

Carbon dioxide is a byproduct of the breakdown of malic acid spilled from damaged cells near the site of a bruise.

To relate carbon dioxide release to the degree of damage, Burton and technician Nancy L. Schulte-Pason dropped freshly harvested cherries and blueberries one to five times from a height of 3 feet. The impacts simulated those that might occur during harvesting and handling.

They immediately placed the dropped fruit in sealed plastic food containers. One hour later, after carbon dioxide accumulated in the containers, needles attached to the intake and exhaust lines of an infrared gas analyzer were inserted into the containers. "The gas analyzer is so sensitive to carbon dioxide that we must be careful in breathing or talking around the machine," Burton says.

The higher the amount of carbon dioxide in a sample, the greater the damage and the higher the amount of eventual decay. The test takes 2 hours compared with a wait of several days for visual observation of decay.

Burton says that information gained from testing fruit can be used to improve mechanical harvesters and the handling equipment in packing houses.

In Michigan, it is estimated that 40 to 50 percent of mechanically harvested cherries and blueberries suffer damage.—By **Linda Cooke-Stinson,** ARS.

Clyde L. Burton is in USDA-ARS Fruit and Vegetable Harvesting Research, Room 138, Plant Biology Lab., Michigan State University, East Lansing, MI 48824 ■

1986 INDEX

A

Aflatoxin detection in almonds (pat.), Aug-16
Africanized bees, screen test for, Feb-6
Air pollution by ozone, Nov/Dec-6
Alfalfa
  computer models, use of, Jan-6
  waxy leaves resist drought, Apr-4
Allelopathic chemicals tested on duckweed, Aug-12
Almonds, detection of aflatoxin (pat.), Aug-16
Antibiotics, antacids, overuse can lead to anemia, Apr-12
Aphids, assault planned with ladybeetles, Jun/Jul-10
Arboretum, U.S. National, plant explorations, Mar-5
Asthma symptoms eased by vitamin B-6, Oct-4
Auxins, plant hormones to prevent juice bitterness, Aug-5
Avian leukosis, Feb-4

B

Bacillus thuringiensis protects stored grain, Jan-5
Bacteria that eat pesticides, Sep-14
Beef, more per acre, Nov/Dec-4
Beef cattle, Senepol, for research, Nov/Dec-11
Bees, test for Africanization, Feb-6
Bigbee, cold-tolerant clover, Jan-4
Biocontrol
  of aphids with lady beetles, Jun/Jul-10
  of caterpillars, Oct-10
  of corn stalk rot, Jun/Jul-12
  of grasshoppers, Sep-4
  of pecan pest, Jun/Jul-5
  for *Rhizoctonia solani* (pat.), Mar-16
Bluetongue virus test (pat.), Jan-16
Bollworm
  eggs devoured by ladybird beetles, Apr-4
  finds okra-leaf cotton less tasty, Mar-5
Bonding, sheep to cattle on rangeland, Jun/Jul-6
Breathalyzer for alcoholic peanuts, Jun/Jul-15

C

Cancer inhibitor found in *Trewia nudiflora* (pat.), Mar-16
Carambola, tropical fruit for U.S., Sep-11
Carbon dioxide, bruised fruit indicator, Nov/Dec-13
CAT scanning livestock, Nov/Dec-4
Cataract prevention through diet or medication, Mar-9
Chromium maintains blood-sugar levels, Jan-4
Clothing, softer permanent-press (pat.), Mar-16
Clover, cold-tolerant variety, Jan-4
Cockroaches killed by neem insecticide, Apr-13
Codling moth
  vacuum fumigation for, Sep-15
  when to spray, Jan-14
Comax, cotton management expert Sep-6
Computer
  identifies wheat by protein patterns, Feb-15
  monitoring of potatoes in storage, Nov/Dec-12
  simulates forage use, Jan-6
Contraband fruit detection (pat.), Oct-16
Corn borer traps (pat.), May-16
Corn xylem signals water need, Mar-12
Cotton
  drying with waste heat, May-14
  expert system, Sep-6
  fibers grown in tissue culture, Feb-6
  multicolor dyeing (pat.), Nov/Dec-16
  moisture sensor (pat.), Sep-16
  okra-leaf less tasty to bollworms, Mar-5
  processing system saves energy, Aug-14
CREAMS, model to predict erosion, runoff, Jan-5
Cuphea, oilseed crop with promise, Feb-12
Cyclodextrin polymer filter for grapefruit juice, Aug-4

D

Debittering citrus juice (pat.), Aug-16
Detector for hidden injuries in fruit, Jan-15
Difenzoquat shortens sunflower stalk internodes, May-4
Dryland farming, Aug-6
Duckweed, used in tests for allelopathy, Aug-12

E

Eggs, liquid, test for spoilage, Oct-15
EHDV, detection of (pat.), Jan-16
Elderly cautioned on antibiotics, antacids, Apr-12
Electroantennograms for medfly, boll weevil, Oct-6
Electron beam finishes leather, Feb-14
Elm, research on Dutch elm disease, Feb-4
Embryo rescue saves new wheatgrass, Apr-15
Estrus in dairy cows, electronically sensed, Nov/Dec-8
Explosion drying of mushrooms, Oct-4

F

Fabrics, nonformaldehyde finishing agents (pat.), Apr-16
Fat, measured by infrared interactance (IRI), Jun/Jul-14
Ferritin, iron-retaining protein, Sep-5
Fertilizer, placement near seeds (pat.), Nov/Dec-16
Fiber
  additive for food (pat.), Oct-16
  supplement for fewer calories, Oct-5
Film, heat-sealable wrap for vegetables (pat.), Feb-16
Flame-retardant clothing (pat.), Mar-16
Flower seed thresher cuts hand labor, Mar-14
Forum
  Breaking the Time Barrier, Oct-2
  E.F. Knipling–A Pioneer in Insect Control, Aug-2
  Genesis From a Single Cell, Apr-2
  Research: Why Invest Now? Feb-2
  Research Would Boost Farm Profits, Exports, May-2
  Scientist Thwarts Yield-Robbing Fungi, Jan-2
  Research: Starting Point for Action, Nov/Dec-2
  The Great Cotton-Yield Mystery, Sep-2
  Wanted: Developers for ARS Inventions, Mar-2
  What Will Bring the Grass Back? Jun/Jul-2
Freeze-dried seeds for storage, Jan-14
Freezing, plums resist damage, Oct-4
Fruit
  bruised, releases carbon dioxide, Nov/Dec-13
  delayed emission of light, Jan-15
  flies, recordings aid sterile-release program, Mar-12
  found in travelers' luggage, Oct-14
  tropical and subtropical, Sep-11
  harvester for trees (pat.), Apr-16
Fuels from vegetable oil, Oct-12
Fungicide pellets for damping-off disease (pat.), Mar-16
Fungus collections of Agricultural Research Service, May-12

G

Gamagrass, eastern, undergoes sex change, Nov/Dec-4
Genetic engineering
  chromosomes injected into cells, Mar-6
  virus for avian leukosis, Feb-4
GLEAMS, model to predict erosion, runoff, Jan-5
Grain, protection in storage, Jan-5
Grapeleaf skeletonizer, lure for (pat.), Jun/Jul-16
Grasshopper virus, control tactic, Sep-4
Greenbugs fooled, Apr-5
Groundwater
  affected by pesticides, Jan-5
  movement studied, Jan-12

H

Hamburger, test for spoilage, Feb-4
Harvester for tree fruit (pat.), Apr-16
Heart disease, genetic indicator found, Aug-13
Heat, savings from relocated air ducts in cotton gins, May-14
Hides, curing faster (pat.), Jan-16
Human nutrition
  chromium maintains blood-sugar levels, Jan-4
  zinc, iron, chromium supplements (pat.), Jan-16
Hydrilla, night light curbs reproduction, Mar-15
Hydrogen peroxide
  treated cornstalks, Oct-5
  treatment for crop wastes, Mar-7

1986 INDEX

I

- Immunoglobulin detection in swine (pat.), Oct-16
- Infrared interactance measures body fat, Jun/Jul-14
- Insects smell with antenna, Oct-6
- Interleukin-1, a polypeptide, Aug-4
- Iron and aging, Sep-5
- Irrigation waste water, Jan-7

J

- Jetstream carries adult aster leafhopper north, Mar-4
- Jornada Experimental Range, Jun/Jul-6
- Juice bitterness prevented by hormones, Aug-5

L

- Lady beetle used to control pecan pest, Jun/Jul-5
- Leaf spot disease in peaches, Oct-8
- Leafhopper hitchhikes on jetstream, Mar-4
- Leather
  - electron beam finishing, Feb-14
  - from pigskins, May-15
- Legumes, cracked seeds allow disease to enter, May-5
- Leucaena toxic to cattle without rare bacterium, Apr-5
- Low-salt foods, method for (pat.), Feb-16

M

- Microinjection of plant cells, Mar-6
- Microphones monitor plants' water needs, Mar-12
- Milk for lactose-intolerant people, Jun/Jul-4
- Mineral
  - deficiency, caused by obesity? Jan-6
  - supplements (pat.), Jan-16
- Mold growth inhibited by natural preservatives (pat.), Apr-16
- Monoclonal antibodies (pat.), Jan-16
- Muscles, produce interleukin-1 when damaged, Aug-4
- Mushrooms, puff-dried, Oct-4

N

- National Clonal Germplasm Repository, apples, grapes, May-4
- Neem kills cockroaches and greenhouse pests, Apr-13
- Nitrogen fixation in soybeans, Oct-11

O

- Obesity
  - enzyme to control, Jun/Jul-4
  - may lead to mineral deficiency, Jan-6
- Ogalalla Aquifer, Aug-8
- Onion, Sweet Sandwich rated mild, May-4
- Ozone
  - preventing damage by, Jan-4
  - damage to crops, Nov/Dec-6

P

- PAGE, polyacrylamide gel electrophoresis, Feb-15
- Papaya
  - hot-water treatment (pat.), Feb-16
  - wax removed by freeze-drying (pat.), Aug-16
- Peach cells screened for disease resistance, Oct-8
- Peanuts, test for bitter flavor, Jun/Jul-15
- Pearl millet pollen in cold storage, Sep-4
- Pecan, pest control with lady beetle, Jun/Jul-5
- Permanent-press fabrics that can be dyed (pat.), Apr-16
- Pesticide drift from airblast systems, May-14
- Pesticides, destroyed by bacteria, Sep-14
- Pheromone
  - for corn borer traps (pat.), May-16
  - lure for spined soldier bugs (pat.), May-16
- Picklemaking, new tank for, Aug-14
- Picolinic acid (pat.), Jan-16
- Pig intestine, in tissue culture, Nov/Dec-4
- Pigskins for leather, May-15
- Plant Introduction System, 500,000th entry, Jun/Jul-4
- Planter, improved punch type (pat.), May-16
- Plastics from surplus corn, soybeans, Oct-12
- Poisonous plants on Western rangeland, May-6
- Pollen, in deep freeze, Sep-4
- Pollution of groundwater studied, Jan-12
- Potato storage monitoring, Nov/Dec-12
- Predators of pink bollworm eggs, Apr-4
- Pyrrolizidine alkaloids cause livestock poisonings, May-8
- Pythium disease of cucumbers, peas (pat.), Sep-16

R

- Refrigerated van for lettuce, melons, grapes, Apr-15
- Rhizomania threatens sugarbeet industry, Jan-11
- Roots, pressure exerted measured, Mar-4
- Roots, washing apparatus for (pat.), Jun/Jul-16

S

- Salty soil, computer mapping of, Jan-7
- Sandfighter, Aug-6
- Seed
  - improved punch planter for (pat.), May-16
  - freeze-dry for long storage, Jan-14
  - grows poorly when soaked, May-5
  - thresher, spinning filament (pat.), Mar-16
- Senepol, new beef cattle, Nov/Dec-11
- Sensing, electonic, of animals, Nov/Dec-8
- Snow trapped by tall wheatgrass barriers, Mar-8
- Soybeans, fixing more nitrogen, Oct-11
- Soy sauce with low salt, Feb-5
- *Sphaeronaemella helvellae*, mold-eating mold, Jun/Jul-12
- Straw converted to livestock feed, Mar-7
- Sugar byproduct debitters grapefruit juice, Aug-4
- Sugarbeet necrotic yellow vein virus, Jan-11
- Sunflowers, dwarfed easier to harvest, May-4
- Surplus crops into plastics (pat.), Oct-16
- Surpluses, source for plastics, Oct-12
- Systematic Entomology Laboratory, Feb-7

T

- TEKTRAN, computerized technology transfer, Sep-15
- Temperature integrator reduces spraying, Jan-14
- Thresher, spinning filament type, Mar-14
- Tissue culture
  - of cotton fibers, Feb-6
  - of pig intestine, Nov/Dec-4
  - propagation, Apr-6
- Tomato product repels grain weevils, Sep-5
- Trailer, refrigerated for produce, Apr-15
- Trees
  - injection to prevent ozone damage, Jan-4
  - wall-off injuries, Mar-10

U-V

- Ultraviolet light finishes leather, Feb-14
- Vapor-locked plants resist freezing, Oct-4
- Viroids, detection of, Apr-8
- Virus, detection of EHDV (pat.), Jan)16
- Vitamin B-6 relieves asthma symptoms, Oct-4
- Vitamin C test more accurate, Jun/Jul-15

W

- Walnuts, unshelled for Japan, Sep-15
- Washer for plant roots (pat.), Jun/Jul-16
- Wasps locate prey by smell, Oct-10
- Waxy leaf alfalfa, Apr-4
- Weed
  - prickly smartweed spreading, Jan-6
  - hydrilla in Potomac River, Mar-15
- Weight-control enzyme, Jun/Jul-4
- Wheat
  - annual cropping with moisture from snow, Mar-8
  - computer identification, Feb-15
  - greenbug control with crop residue, Apr-5
  - purplestraw, Jun/Jul-4
  - protected by 2-tridecanone, Sep-5
- Wheatgrass grown from cross-incompatible parents, Apr-15
- Wind-driven alternators and generators (pat.), Oct-16
- Wind tunnel checks pesticide spray drift, May-14

X-Y

- X-ray for imaging live animals, Nov/Dec-4
- X-ray system detects fruit, plants, Oct-14
- Yellowjackets lured by chemical bait, May-10

U.S. Department of Agriculture
Agricultural Research Service
Rm. 318, B-005, BARC-WEST
Beltsville, MD 20705
Official Business

Bulk Rate
Postage and Fees Paid
U.S. Department of Agriculture
Permit No. G—95

To stop mailing ☐ or to change your address ☐ send mailing label on this magazine and new address to Agricultural Research, Rm. 318, B-005, BARC-West, Beltsville, MD 20705

PATENTS

A Tidy Way To Plant and Fertilize

A new planter attachment applies fertilizer at just the right distance from seeds and disturbs the soil about half as much as a previous USDA invention.

The device has two blades to open furrows: the lower blade is about 1/4 to 1/2 inch thick and ends in a point; the upper blade has an elongated rectangular flat leading face that is preferably 1 to 2½ inches thick.

Both blades are attached to a hollow shank that connects to planters. A tube runs from the fertilizer tank through the shank and down the trailing edge of the bottom blade. Urea ammonium nitrate flows through the tube into the lower, narrow furrow.

Seeds drop from the seeding machine through a tube into the hollow shank. There they fall out the bottom of the shank into the broad furrow cut by the upper blade.

The two-blade arrangement guarantees the necessary separation between seed and fertilizer. Fertilizer placed too close to the seed can prevent it from sprouting.

Farmers using conservation tillage can't spread their fertilizer on the surface because it gets tied up in the decomposition of crop residue. They need a machine that puts fertilizer close, but not too close, to the seeds.

They also need a planter that causes minimal soil disturbance. When this new device was tested with wheat planting in Oregon, it left soil ridges only 2½ inches high compared with the 4½-inch-high ridges left by an earlier USDA modified planting device.

For technical information, contact Dale E. Wilkins, USDA-ARS Columbia Plateau Conservation Research Center, P.O. Box 370, Pendleton, OR 97801. *Patent Application Serial No. 06/876,047, "Method and Apparatus for Placement of Fertilizer Below Seed With Minimum Soil Disturbance."* ■

Colorful Cotton

One of many things that has held cotton back in its competition with synthetics is the difficulty of dyeing the fabric more than one color after it's made.

This new process makes multicolor dyeing more practical by treating the yarn so it can be dyed after it is made into fabric. The yarn running in one direction, usually lengthwise (warp), is treated to accept certain dyes under mildly acidic conditions. The untreated yarn running the width of the fabric (filling) will accept dyes under conventional alkaline conditions.

Current methods require dyeing the yarn before it is turned into a finished product, limiting the manufacturer's choice of color combinations.

For technical information, contact Robert J. Harper, Jr., USDA-ARS Southern Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124. *Patent Application Serial No. 878,106, "Process for Crossdyeing Cellulosic Fabrics."* ■

How To Obtain a License for USDA Patents

For technical information on patents listed on this page, contact the researcher or the Coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705.

If you are interested in applying for a license on a patent or receiving a catalog of USDA patents, write to the Coordinator.

Copies of existing patents may be purchased from the Commissioner of Patents and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. ■